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R.D. STENNER

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NPL CANDIDATE

~~Update #~~

SEP 1 4 1987

Facility name: U.S. DOE Hanford 300 Area ~~Received~~

Location: Hanford Site

EPA Region: X

Person(s) in charge of the facility: J. J. Keating, Asst. Mgr.
Safety, Environment and Security
509 - 376 - 7334

Name of Reviewer: D. M. Bennett, EPA Region X Date: 8-15-87

General description of the facility:
(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

The 300 Area Site contains the 316-1, 316-2, 316-3, 316-4, 618-1, 618-2, 618-3, 618-4, 618-5, 618-7, 618-9, 618-12, 618-13, and the Horn Rapids Solid Waste Disposal sites. The above 600 numbered sites were included in the 300 Area because of their close proximity to the 300 numbered sites. The ground water and surface water are the routes of major concern. The individual sites listed above are either surface impoundments (i.e., ponds or trenches) or landfills (i.e., land disposal). The 300 Area is located approximately 3 miles north of the Richland city limits.

Scores: $S_M = 65.23$ ($S_{gw} = 79.60$ $S_{sw} = 80.00$ $S_a = 0.00$)

$S_{FE} = 0.00$

$S_{OC} = 0.00$

FIGURE 1
HRS COVER SHEET

1/6/88

9113218.0690

NPL-U7-2-232

National Priorities List

Superfund hazardous waste site listed under the
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended in 1986

HANFORD 300-AREA (USDOE)
Benton County, Washington

The Hanford 300-Area is adjacent to the Columbia River in the southern section of the 570-square-mile Hanford Site approximately 3 miles north of the City of Richland, Benton County, Washington. Since 1943, Hanford has been the scene of Federal nuclear activities, primarily production of nuclear materials for national defense.

The U.S. Department of Energy (USDOE) fabricates nuclear reactor fuel in the 300-Area, which contains 14 disposal locations. The disposal locations and plumes of contaminated ground water cover approximately 5 square miles.

An estimated 27 million cubic yards of solid and dilute liquid wastes comprised of radioactive, mixed, and hazardous constituents were disposed of in ponds, trenches, and landfills in the 300-Area. USDOE detected uranium in area springs, wells, and the Columbia River at levels significantly above background. Almost 70,000 people use ground water and surface water for drinking within 3 miles of the 300-Area.

EPA, USDOE, and the Washington Department of Ecology are jointly developing an action plan that will include the work needed to address this area under the Superfund program, as well as other work needed to meet permitting, corrective action, and compliance requirements of Subtitle C of the Resource Conservation and Recovery Act.

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Safety, Environment and Security
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Scores: S_M = 65.23 (S_{gw} = 79.59 S_{sw} = 80.00 S_a = 0.00)

S_{FE} = 0.00

S_{DC} = 0.00

FIGURE 1
HRS COVER SHEET

6/9/88

HRS Ground Water Route Work Sheet

Site: U.S. DOE Hanford 300 Area 8/15/87

Rating Factor	Assigned Value	Multi-plier	Score	Max. Score	Ref. (Section)
1. Observed Release	45	1	45	45	3.1
If observed release is given a score of 45, proceed to line 4. If observed release is given a score of 0, proceed to line 2.					
2. Route Characteristics					3.2
Depth to Aquifer of Concern	0	2	0	6	
Net Precipitation	0	1	0	3	
Permeability of the Unsaturated Zone	0	1	0	3	
Physical State	0	1	0	3	
Total Route Characteristics Score			0	15	
3. Containment	0	1	0	3	3.3
4. Waste Characteristics					3.4
Chemical					
a. Toxicity/Persistence	18	1	18	18	
Hazardous Waste Quantity	8	1	8	8	
Total Waste Characteristics Score			26	26	
5. Targets					3.5
Ground Water Use	3	3	9	9	
Distance to Nearest Well/ Population Served	30	1	30	40	
Total Targets Score			39	59	
6. If line 1=45 (1x4x5) If line 1=0 (2x3x4x5)			45630	57330	
7. Line 6/57330 * 100	Sc(gw)=	79.59			

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Maestas Bailey
6/9/89

HRS Surface Water Route Work Sheet

Site: U.S. DOE Hanford 300 Area 8/15/87

Rating Factor	Assigned Value	Multi-plier	Score	Max. Score	Ref. (Section)
1. Observed Release	45	1	45	45	4.1
If observed release is given a score of 45, proceed to line 4. If observed release is given a score of 0, proceed to line 2.					
2. Route Characteristics					4.2
Facility Slope & Intervening Terrain	0	1	0	3	
1-yr. 24-hr. Rainfall	0	1	0	3	
Distance to Nearest Surface Water	0	2	0	6	
Physical State	0	1	0	3	
Total Route Characteristics Score			0	15	
3. Containment	0	1	0	3	4.3
4. Waste Characteristics					4.4
a. Chemical					
Toxicity/Persistence	18	1	18	18	
Hazardous Waste Quantity	8	1	8	8	
Total Waste Characteristics Score			26	26	
5. Targets					4.5
Surface Water Use	3	3	9	9	
Distance to a Sensitive Environment	0	2	0	6	
Population Served/Distance to Water Intake Downstream	35	1	35	40	
Total Targets Score			44	55	
6. If line 1=45 (1x4x5) If line 1=0 (2x3x4x5)			51480	64350	
7. Line 6/64350 * 100	Sc(sw)= 80.00				

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HRS Air Route Work Sheet

ROUTE NOT SCORED

Rating Factor	Assigned Value	Multi-plier	Score	Max. Score	Ref. (Section)
1. Observed Release	0	1	0	45	5.1
Date and Location:					
Sampling Protocol:					

If observed release is given a score of 45, proceed to line 2.
If observed release is given a score of 0, the Sa=0. Enter on Line 5.

Rating Factor	Assigned Value	Multi-plier	Score	Max. Score	Ref. (Section)
2. Waste Characteristics					5.2
a. Chemical Reactivity and Incompatibility	0	1	0	3	
Toxicity	0	3	0	9	
Hazardous Waste Quantity	0	1	0	8	
Total Waste Characteristics Score			0	20	
3. Targets					5.3
Population Within 4-Mile Radius	0	1	0	30	
Distance to Sensitive Environment	0	2	0	6	
Land Use	0	1	0	3	
Total Targets Score			0	39	
4. Multiply 1 x 2 x 3			0	35100	

5. Line 4/35100 * 100 Sc(a)= 0.00

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	S	S^2
Groundwater Route Score (S_{gw})	79.59	6334.57
Surface Water Route Score (S_{gw})	80.00	6400.00
Air Route Score (S_a)	0.00	0.00
$S_{gw}^2 + S_{sw}^2 + S_a^2$	-	12734.57
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$	-	112.85
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} \;/\; 1.73 = S_M =$	-	65.23

FIGURE 10
WORKSHEET FOR COMPUTING S_M

DOCUMENTATION RECORDS
FOR
HAZARD RANKING SYSTEM

INSTRUMENTATIONS: As briefly as possible summarize the information you used to assign the score for each factor (e.g., "Waste quantity = 4,230 drums plus 800 cubic yards of sludge"). The source of information should be provided for each entry and should be a bibliographic-type reference, include the location of the document.

FACILITY NAME: U.S. DOE Hanford 300 Area

LOCATION: Hanford Site, Benton County, Washington

DATE SCORED: 8-15-87

PERSON SCORING: R. D. Stenner, Pacific Northwest Laboratory for DOE

PRIMARY SOURCE(S) OF INFORMATION (e.g., EPA region, state, FIT, etc.):

The information was taken from Department of Energy documents and databases associated with the Hanford Site, as well as from other publicly available documents addressing conditions at or in the vicinity of the Hanford Site. Information was also gathered through telephone and personal communications with responsible individuals (such information is referenced accordingly in the package).

FACTORS NOT SCORED DUE TO INSUFFICIENT INFORMATION:

Even though air concentrations of some of the constituents of interest can be detected above background offsite, no air monitoring data were found sufficient for HRS scoring of the Hanford CERCLA sites. These constituents of interest detected above background offsite are present in the routine gaseous effluents from operating facilities at Hanford. Therefore, the air route rating factors were not scored.

COMMENTS OR QUALIFICATIONS:

The Department of Energy has completed a preliminary assessment of the hazardous waste sites located on the Hanford Site. This work served as the primary basis for developing the scores for the aggregate 300 Area Site. These preliminary assessment efforts are documented in the "Draft Phase I Installation Assessment of Inactive Waste-Disposal Sites at Hanford" volumes and respective addenda which are referenced throughout this package.

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GROUND WATER ROUTE

1 OBSERVED RELEASE

Contaminants detected (5 maximum):

An observed release from the 300 Area can be verified utilizing uranium as the contaminant detected. Verification of uranium in ground water beneath the 300 Area can be established by comparison of background concentrations and down gradient concentrations. The following table presents the background and down gradient concentrations (with associated wells and dates) that substantiate this conclusion.

BACKGROUND			DOWN GRADIENT		
Date	Well	Concentration (pCi/L)	Date	Well	Concentration (pCi/L
2/20/86	3-8-1	6.6 ± 2.3	2/20/86	3-4-10	32 ± 5.0
2/20/86	3-8-4	5.1 ± 2.1	2/20/86	3-3-12	30 ± 4.9
			1/29/86	3-4-7[a]	42 ± 5.3

(a) This well was used to document distance to target ground water well.

Reference 1; Reference 2, pages 3, 4, 174-176; Reference 3; Reference 4.

Rationale for attributing the contaminants to the facility:

Most of the facilities in the 300 Area, completed in 1943 and the years immediately following, were used to support the fabrication of reactor fuel. The fuel fabrication process forms the zirconium cladding and the uranium-silicon fuel core from primary material components and bonds the two together in one operation. The activities here included many technical and service support functions, as well as fuel manufacturing. As the Hanford production reactors were shut down, fuel-manufacturing activities decreased. These activities resulted in uranium contaminated waste being disposed of in the 300 Area, and down gradient wells show uranium concentration levels significantly above the uranium concentrations found in background wells.

Reference 6, pages 2.24-2.25, Reference 22, Reference 7.

2 ROUTE CHARACTERISTICS

Depth to Aquifer of Concern

Name/description of aquifer(s) of concern:

The aquifer of concern is the unconfined aquifer which is comprised of the glacio fluvial sediments of the Hanford formation and the late deposits of the Ringold formation. It generally slopes downward from west to east; depth to ground water is from 10 to 15 meters (34 to 48 feet). It is bounded below

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by either the basalt surface or, in places, the relatively impervious clays and silts of the lower unit of the Ringold formation. Laterally, the unconfined aquifer is bounded by the anticlinal basalt ridges that ring the basin. The Yakima and Columbia Rivers, however, do not entirely transect these sediments and therefore do not constitute a discontinuity for HRS Scoring purposes. The basalt ridges above the water table have a low permeability and act as a barrier to lateral flow of the ground water. The saturated thickness of the unconfined aquifer is approximately 43 meters in this area of the Hanford Site and pinches out along the flanks of the basalt anticlines.

Recharge to the unconfined aquifer originates from several sources. Natural recharge occurs from precipitation at higher elevations and runoff from ephemeral streams to the west, such as Cold Creek and Dry Creek. The Yakima River recharges the unconfined aquifer as it flows along the southwest boundary of the Hanford Site. The Columbia River recharges the unconfined aquifer during high stages when river water is transferred to the aquifer along the river bank. The unconfined aquifer receives little recharge from precipitation directly on the Hanford Site because of a high rate of evapotranspiration under native soil and vegetation conditions. Large scale artificial recharge occurs from offsite agricultural irrigation and liquid-waste disposal in the operating areas at Hanford.

Underlying the surface sands is a mixture of sand and gravel extending to a depth of 40-60 meters. Basaltic rock starts at that depth and extends downward over 1.9 miles (3000 meters).

Reference 6, page 2.24; Reference 7, page 2.1-2.7; Reference 25; Reference 26

Depth(s) from the ground surface to the highest seasonal level of the saturated zone [water table(s)] of the aquifer of concern:

Not applicable.

Depth from the ground surface to the lowest point of waste disposal/storage:

Not applicable.

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Net Precipitation

Mean annual or seasonal precipitation (list months for seasonal):

Not applicable.

Mean annual lake or seasonal evaporation (list months for seasonal):

Not applicable.

Net precipitation (subtract the above figures):

Not applicable.

Permeability of Unsaturated Zone

Soil type in unsaturated zone:

Not applicable.

Permeability associated with soil type:

Not applicable

Physical State

Physical state of substances at time of disposal (or at present time for generated gases):

Not applicable.

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3 CONTAINMENT

Containment

Method(s) of waste or leachate containment evaluated:

Not applicable.

Method with highest score:

Not applicable.

4 WASTE CHARACTERISTICS

Toxicity and Persistence

Compound(s) evaluated:

The substances listed below are involved in the fuel element fabrication process, which takes place in the 300 Area.

Substances in the 300 Area

Sodium hydroxide (sodium)
Nitrite, nitrate
Mercury
Chromium (VI)
Cadmium (II)
Lead (II)
Trichloroethylene
Uranium
Zinc
Nickel
Nitric acid
Methyl isobutyl ketone
Copper
Beryllium
Cobalt-60
Promethium-147
Plutonium
Tributyl Phosphate
Strontium-90
Cesium-137

Reference 6, pages 2.24-2.25; Reference 8, pages 665-672, 675-684, 687-688, 691-692, 697-700, 707-708

Compound with highest score:

Several of these substances results in a score of 18. Uranium, mercury, beryllium and plutonium are among those having scores of 18.

Substance	Toxicity Score	Persistence Score	TOTAL Score
Uranium	3	3	18
Mercury	3	3	18
Chromium	3	3	18
Plutonium	3	3	18

Reference 9, pages 794-797; Reference 28

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Hazardous Waste Quantity

Total quantity of hazardous substances at the facility, excluding those with a containment score of 0 (Give a reasonable estimate even if quantity is above maximum):

The total quantity of hazardous substances associated with the aggregate 300 Area Site is at least 27 million cubic yards. Table 1 presents the individual sites and associated data that were used in creating the aggregate 300 Area Site. Table 1 lists several sites that were early solid waste disposal sites for which the quantity of wastes are unknown; thus, the associated quantity is estimated to be at least 27 million cubic yards.

References are listed by waste site in Table 1.

Basis of estimating and/or computing waste quantity:

Most of the facilities in the 300 Area, completed in 1943 and the years immediately following, were used to support the fabrication of reactor fuel. The activities here included many technical and service support functions, as well as fuel manufacturing. As the Hanford production reactors were shut down, fuel-manufacturing activities decreased and other activities increased.

The fuel elements are fabricated by a coextrusion process. This process forms the zirconium cladding and the uranium-silicon fuel core from primary material components and bonds the two together in one operation. The fuel elements are protected with a copper jacket for the extrusion process. The jacket also prevents atmospheric contamination of the reactive fuel element, and the copper is easily lubricated for extrusion. Lubricants are removed using organic solvents such as trichlorethylene. After extrusion into billets, the copper is removed by dissolution into nitric acid. The uranium core is recessed by chemical milling so that the billets can receive an end cap. The chemical milling is performed using copper sulfate, nitric acid, and sulfuric acid. A zirconium end cap is then brazed on with beryllium. The fuel elements are tested for cap attachment, cap to core bonding, cladding to core bonding, and cladding to cap bonding before fuel-element supports and locking clips are attached. Next, the tubes are autoclaved for 72 hours in $360^{\circ}C$ ($680^{\circ}F$) steam to detect any perforations in the cladding or end caps. Finally, the elements are packaged for storage and shipment.

The quantities of the various constituents in the waste associated with each individual waste site were compiled as part of the preliminary assessment effort which is reported in the "Draft Phase I Installation Assessment of Inactive Waste-Disposal Sites At Hanford" volumes and addenda.

Reference 6, pages 2.24-2.25; Reference 6 and Reference 8 (See individual references in Table 1 for applicable pages), Reference 24.

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TABLE 1. Basis of Estimating and/or Computing Waste Quantity - 300 Area

Area No. and Name	Waste Types	Years	Estimated Volume	No. of Cubic Yds[(a)]	References
316-1, 300 Area South Process Pond	Cooling water and low-level liquid wastes from fuel fabrication operations and incidental wastes from other facilities in the 300 Area. Wastes contained uranium, copper, chromium, lead, beryllium, mercury, silver, cadmium, nickel, zinc. fluoride, trichloroethylene, methylisobutyl, ketone, nitric acid and nitrite ion. Radionuclides include Co-60.	1943-1975	10 billion L	13 million	6, page B.19 8, pages 665 and 666
316-2, 300 Area North Process Pond	Same as above.	1949-1974	10 billion L	13 million	6, page B.19 8, pages 667 and 668

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Area No. and Name	Waste Types	Years	Estimated Volume	Cubic Yds[(a)]	References
316-3, 307 Disposal Trenches	Wastes from Works Laboratory Area (329, 327, 325 and 326 Buildings) and sludge from 316-1 pond. Sludge contains uranium, copper, chromium, lead, beryllium, mercury, silver, cadmium, nickel, zinc and fluoride. Radionuclides include cobalt-60.	1953-1963	1 billion L	1.3 million	6, page B.19 8, pages 669 and 670
316-4	Water contaminated with hexone- (methyl isobutyl ketone) bearing uranium wastes and other uranium-bearing wastes from the 321 Bldg. No data available on amount of radionuclides disposed.	1948-1956	200,000 L	260	6, page B.21 8, pages 671 and 672
600 Area solid waste burial sites (618 series, 1, 2, 3, 4, 5, and 12)	Uranium-contaminated material with other radionuclides Sr-90, Cs-137 and Pu-239.	1945-1973	Unknown	Unknown	6, page B.21 8, pages 675-684, 689, 690, 691 and 698

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Area No. and Name	Waste Types	Years	Estimated Volume	No. of Cubic Yds[(a)]	References
600 Area solid waste burial site (618-7)	Wastes containing uranium, thorium and beryllium.	1960-1973	Unknown	Unknown	6, page B.21 8, pages 687 and 688
600 Area solid waste burial site (618-9)	Drummed waste containing uranium, tributyl phosphate and paraffin hydrocarbon.	1950-1956	Unknown	Unknown	6, page B.21 8, pages 691 and 692
600 Area solid Waste Disposal Site (618-13)	Radioactive-contaminated soil.	1950-1950	Unknown	Unknown	6, page B.2 8, pages 699 and 700
Horn Rapids Solid Waste Disposal Site	Wastes generated in 1100 Area, including paint cans, solvents and oils.	1950-1970	Unknown	Unknown	6, page B.21 8, pages 707 and 708 27, pages 1 and 2

(a) Conversion factor used to compute cubic yards from liters is 764 L/cu yd.

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5 TARGETS

Ground Water Use

Use(s) of aquifer(s) of concern within a 3-mile radius of the facility:

Drinking Water:

The City of Richland drinking water recharge wells are within 3 miles of the site and draw water from the aquifer (of concern). There are 14 of these recharge wells having depths that range from 40 feet to 134 feet. The recharge wells are part of the Richland's water supply system. These wells are designed to be used in conjunction with the water supply holding ponds located beside the wells. The recharge well system is used during peak water demand periods and when the Columbia River water pump system is down for maintenance. The recharge system operates with water being pumped to the holding ponds from the Columbia River; the water in the holding ponds then filters through the soil column to the aquifer where it is pumped by the recharge wells to the city's supply system. The water drawn from the recharge wells then becomes mixed with the total water in the Richland system (i.e., water from the river water treatment system) and is distributed through out the city.

Drinking water for private residences in the city is supplied by the Richland City Water System. Since the city water system draws from either the wells or the river, there is no municipal water from alternate unthreatened sources presently available. There are 15 wells (private wells within 3 miles) located across the Columbia River from the 300 Area with unknown depth.

Reference 10; Reference 11; Reference 19

Irrigation Water:

The Battelle (BNW) Farm Operations irrigation well (RRC well located near the OSB Building in the Hanford 3000 Area) is within 3 miles of the 300 Area.

Reference 11; Reference 12

Distance to Nearest Well

Location of nearest well drawing from aquifer of concern or occupied building not served by a public water supply:

The well closest to the edge of the 300 Area uranium plume is the Battelle Irrigation Well, which is 1.5 miles south of the edge of the plume.

Reference 7, pages 3.22-3.23; Reference 11, Reference 12.

Distance to above well or building:

The Battelle Irrigation Well is located 1.5 miles from the edge of the plume.

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Reference 7, pages 3.22-3.23; Reference 11

Population Served by Ground Water Wells Within a 3-Mile Radius

Identified water-supply well(s) drawing from aquifer(s) of concern within a 3-mile radius and populations served by each:

There are 14 Richland recharge wells located within 3 miles of the site that draw water from the aquifer. As discussed above, the recharge wells are used by the city to supplement the water supply during peak periods. The water from the wells is mixed in with the water in the system from the Columbia River and distributed through out the city. Thus, the population of Richland is used for the population served by the wells. Based on the 1980 sensus, the Richland population is 33,578.

The population of Kennewick, Washington, is also considered because the Richland City Water Supply System has an emergency water intertie to the Kennewick Water Supply System. The population of Kennewick is 34,387.

The 300 Area worker population is also considered because the 300 Area has an emergency intertie with the Richland City Water System. The population of the 300 Area workers is 3,110.

Reference 10; Reference 13, Figure 4.11, pages 4.32-4.33; Reference 20, page 3.

The Benton Franklin District Health Department was contacted in an effort to establish the locations of any wells (drawing from the unconfined aquifer) across the Columbia River from the site that might be in the 3-mile range of the site. The total number of wells within the defined 3-mile radius boundary is 15 private single dwelling wells. It is estimated that 57 people are served by the single dwelling wells.

No data were available regarding the depth and screen intervals of these private wells; therefore, they were not included in the private well count.

Reference 19

Computation of land areas irrigated by supply well(s) drawing from aquifer(s) of concern within a 3-mile radius, and conversion to population (1.5 people per acre):

The Battelle Farm Operations RRC well, which has a depth of 50 feet, is located within 3 miles of the site. The farm operations draw water from the well and from the river to irrigate the forage crops that are grown. The BNW irrigation operations cover a total of 168 acres. Using the 1.5 people per acre criteria, this results in an affected population of:

(168 acres) (1.5 people/acre) = 252

Reference 12; Reference 11

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Total population served by ground water within a 3-mile radius:

The total population served is the result of summing the population of the city of Richland and the estimated population associated with the Battelle Farm Operations. The total estimated affected population is:

33,578 + 34,387 + 252 = 68,217

This total does not include the 3110 300-Area workers since they would also be counted in the City of Richland and City of Kennewick numbers. This will avoid double counting of populations.

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SURFACE WATER ROUTE

1 OBSERVED RELEASE

Contaminants detected in surface water at the facility or downhill from it (5 maximum):

There was an observed release to surface water from the 300 Area springs which are known to seep into the Columbia River. The observed release was verified utilizing uranium as the contaminant detected. Significant concentrations of Uranium were noted in spring water samples as described in McCormick and Carlile 1984. The following table presents the spring water concentrations (with associated sample points and dates) that substantiate the observed release.

SPRING WATER

Date	Sample Point	Concentration (pCi/L)
12/20/82	41-1 Spg	9.03 ± 3.16
12/20/82	42-1 Spg	15.4 ± 5.4
01/22/83	42-1 Spg	19.0 ± 6.64
12/20/82	43-3 Spg(a)	2.99 ± 1.05

(a) This spring entry point was used to establish distance to target population.

Reference 14, pages 18, A.6, C.7-C.8; Reference 15; Reference 6, page 2.10

Rationale for attributing the contaminants to the facility:

Most of the facilities in the 300 Area, completed in 1943 and the years immediately following, were used to support the fabrication of reactor fuel. The fuel fabrication process forms the zirconium cladding and the uranium-silicon fuel core from primary material components and bonds the two together in one operation. The activities here included many technical and service support functions, as well as fuel manufacturing. As the Hanford production reactors were shut down, fuel-manufacturing activities decreased. These activities resulted in uranium contaminated waste being disposed of in the 300 Area, and down gradient samples show uranium concentration levels significantly above the uranium concentrations found in background samples.

Reference 6, pages 2.24-2.25, Reference 22, Reference 11.

2 ROUTE CHARACTERISTICS

Facility Slope and Intervening Terrain

Average slope of facility in percent:

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Not applicable.

Name/description of nearest down slope surface water:

The Columbia River, which originates in the mountains of eastern British Columbia, Canada, flows through the northern edge of the Hanford Site and forms part of the Hanford Site's eastern boundary. The river drains a total area of approximately 70,800 km^2 enroute to the Pacific Ocean. The flow of the Columbia River is regulated by 11 dams within the United States, 7 upstream and 4 downstream of the Site. Priest Rapids Dam is the nearest impoundment upstream of the Site, and McNary Dam is the nearest dam downstream. (The Hanford reach of the Columbia River extends from Priest Rapids Dam to the head of Lake Wallula, which is created by McNary Dam.) This is the only stretch of the Columbia River within the U.S. that is not impounded by a dam. The width of the river varies from approximately 300 m to about 1000 m. The flow through this stretch of the river is relatively swift, with numerous bends and several islands present throughout the reach. The ground water beneath the site discharges directly into the Columbia River as evidenced by seeps and springs in the 300 Area.

The flow rate of the Columbia River in this region is regulated primarily by Priest Rapids Dam. Hanford reach flows fluctuate significantly because of the relatively small storage capacity and operational practices of the nearby upstream dams. A minimum flow rate of 1,000 cubic meters per second (36,000 cubic feet per second) has been established at Priest Rapids. Typical daily flows range from 1,000 cubic meters per second (36,000 cubic feet per second) to 7,000 cubic meters per second (250,000 cubic feet per second) with peak spring runoff flows of up to 12,600 cubic meters per second (450,000 cubic feet per second) being recorded. Typical annual average flows at Priest Rapids Dam are 3,100 cubic meters per second (110,000 cubic feet per second) to 3,400 cubic meters per second (120,000 cubic feet per second). Monthly mean flows typically peak from April through June and are at the lowest levels from September through October.

The depth at the deepest part of the measured cross-sections varies approximately from 10 to 40 feet, with an average around 25 feet. Daily fluctuations in depth caused by Priest Rapids regulation can be as much as 10 feet above Vernita and 5 feet at Hanford.

Reference 7, page 2.1; Reference 25, page II.3-13.

Average slope of terrain between facility and above-cited surface water body in percent:

Not applicable.

Is the facility located either totally or partially in surface water?

The facility itself is located on the bank of the Columbia River. Uranium concentrations, attributable to the 300 Area site, in the river is projected to extend to river mile 43.8.

Reference 14, page 18 and C.8

Harold D Bolde
1/5/88

Is the facility completely surrounded by areas of higher elevation?

Not applicable.

1-Year 24-Hour Rainfall in Inches

Not applicable.

Distance to Nearest Down slope Surface Water

Not applicable.

Physical State of Waste

Not applicable.

3 CONTAINMENT

Containment

Method(s) of waste or leachate containment evaluated:

Not applicable.

Method with highest score:

Not applicable.

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4 WASTE CHARACTERISTICS

Toxicity and Persistence

Compound(s) evaluated

The substances listed below are involved in the fuel element fabrication process, which takes place in the 300 Area.

Substances in the 300 Area

Sodium hydroxide (sodium)	Uranium	Cobalt-60
Nitrite, nitrate	Zinc	Promethium-147
Mercury	Nickel	Plutonium
Chromium (VI)	Nitric acid	Tributyl Phosphate
Cadmium (II)	Methyl isobutyl ketone	Strontium-90
Lead (II)	Copper	Cesium-137
Trichloroethylene	Beryllium	

Reference 6, pages 2.24-2.25; Reference 8, pages 665-672, 675-684, 687-688, 691-692, 697-700, 707-708

Compound with highest score:

Several of these substances results in a score of 18. Uranium, mercury, beryllium and plutonium are among those having scores of 18.

Substance	Toxicity Score	Persistence Score	TOTAL Score
Uranium	3	3	18
Mercury	3	3	18
Chromium	3	3	18
Plutonium	3	3	18

Reference 9, pages 794-797; Reference 28

Hazardous Waste Quantity

Total quantity of hazardous substances at the facility, excluding those with a containment score of 0 (Give a reasonable estimate even if quantity is above maximum):

The total quantity of hazardous substances associated with the aggregate 300 Area Site is at least 27 million cubic yards. Table 1 presents the individual sites and associated data that were used in creating the aggregate 300 Area Site. Table 1 lists several sites that were early solid waste disposal sites for which the quantity of wastes are unknown; thus, the associated quantity is estimated to be at least 27 million cubic yards.

References are listed by waste site in Table 1.

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Basis of estimating and/or computing waste quantity:

Most of the facilities in the 300 Area, completed in 1943 and the years immediately following, were used to support the fabrication of reactor fuel. The activities here included many technical and service support functions, as well as fuel manufacturing. As the Hanford production reactors were shut down, fuel-manufacturing activities decreased and other activities increased.

The fuel elements are fabricated by a coextrusion process. This process forms the zirconium cladding and the uranium-silicon fuel core from primary material components and bonds the two together in one operation. The fuel elements are protected with a copper jacket for the extrusion process. The jacket also prevents atmospheric contamination of the reactive fuel element, and the copper is easily lubricated for extrusion. Lubricants are removed using organic solvents such as trichlorethylene. After extrusion into billets, the copper is removed by dissolution into nitric acid. The uranium core is recessed by chemical milling so that the billets can receive an end cap. The chemical milling is performed using copper sulfate, nitric acid, and sulfuric acid. A zirconium end cap is then brazed on with beryllium. The fuel elements are tested for cap attachment, cap to core bonding, cladding to core bonding, and cladding to cap bonding before fuel-element supports and locking clips are attached. Next, the tubes are autoclaved for 72 hours in $360^{\circ}C$ ($680^{\circ}F$) steam to detect any perforations in the cladding or end caps. Finally, the elements are packaged for storage and shipment.

The quantities of the various constituents in the waste associated with each individual waste site were compiled as part of the preliminary assessment effort which is reported in the "Draft Phase I Installation Assessment of Inactive Waste-Disposal Sites At Hanford" volumes and addenda. In compiling the inventory, it was assumed that since ground water seeps into the Columbia River, the containment associated with the surface water route is considered not to be 0, and all the waste quantities cited were available for migration.

Reference 6, pages 2.24-2.25; Reference 6 and Reference 8 (See individual references in Table 1 for applicable pages), Reference 24.

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TABLE 1. Basis of Estimating and/or Computing Waste Quantity - 300 Area

Area No. and Name	Waste Types	Years	Estimated Volume	No. of Cubic Yds[(a)]	References
316-1, 300 Area South Process Pond	Cooling water and low-level liquid wastes from fuel fabrication operations and incidental wastes from other facilities in the 300 Area. Wastes contained uranium, copper, chromium, lead, beryllium, mercury, silver, cadmium, nickel, zinc. fluoride, trichloroethylene, methylisobutyl, ketone, nitric acid and nitrite ion. Radionuclides include Co-60.	1943-1975	10 billion L	13 million	6, page B.19 8, pages 665 and 666
316-2, 300 Area North Process Pond	Same as above.	1949-1974	10 billion L	13 million	6, page B.19 8, pages 667 and 668

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Area No. and Name	Waste Types	Years	Estimated Volume	Cubic Yds(a)	References
316-3, 307 Disposal Trenches	Wastes from Works Laboratory Area (329, 327, 325 and 326 Buildings) and sludge from 316-1 pond. Sludge contains uranium, copper, chromium, lead, beryllium, mercury, silver, cadmium, nickel, zinc and fluoride. Radionuclides include cobalt-60.	1953-1963	1 billion L	1.3 million	6, page B.19 8, pages 669 and 670
316-4	Water contaminated with hexone- (methyl isobutyl ketone) bearing uranium wastes and other uranium-bearing wastes from the 321 Bldg. No data available on amount of radionuclides disposed.	1948-1956	200,000 L	260	6, page B.21 8, pages 671 and 672
600 Area solid waste burial sites (618 series, 1, 2, 3, 4, 5, and 12)	Uranium-contaminated material with other radionuclides Sr-90, Cs-137 and Pu-239.	1945-1973	Unknown	Unknown	6, page B.21 8, pages 675-684, 689, 690, 691 and 698

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Area No. and Name	Waste Types	Years	Estimated Volume	No. of Cubic Yds(a)	References
600 Area solid waste burial site (618-7)	Wastes containing uranium, thorium and beryllium.	1960-1973	Unknown	Unknown	6, page B.21 8, pages 687 and 688
600 Area solid waste burial site (618-9)	Drummed waste containing uranium, tributyl phosphate and paraffin hydrocarbon.	1950-1956	Unknown	Unknown	6, page B.21 8, pages 691 and 692
600 Area solid Waste Disposal Site (618-13)	Radioactive-contaminated soil.	1950-1950	Unknown	Unknown	6, page B.2 8, pages 699 and 700

(a) Conversion factor used to compute cubic yards from liters is 764 L/cu yd.

[illegible] 1/5/88

5 TARGETS

Surface Water Use

Use(s) of surface water within 3 miles downstream of the hazardous substance:

The Richland drinking water intake is within 3 miles of the detectable uranium concentrations in the river downstream of the 300 Area (i.e., river mile 43.8). The 300 Area also has an intake from the river that is used for both drinking and process water. This intake is located within the stretch of river with detectable uranium concentrations and, thus, within the borders of the site.

The Tri-Cities University Center has an intake from the river, which is used for irrigation. Also, the Battelle Farm operations has an intake from the river, which is used to draw water for irrigation purposes. Both the Tri-City University Center irrigation intake and the Battelle Farm operations irrigation intake are within 3 miles of the site.

The river is also used for recreation.

Reference 16; Reference 17; Reference 11; Reference 23

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Is there tidal influence?

The site is located upstream of four dams, therefore, there is no tidal influence at the site.

Reference 7, page 2.1

Distance to a Sensitive Environment

Distance to 5-acre (minimum) coastal wetland, if 2 miles or less:

Not applicable.

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Distance to 5-acre (minimum) fresh-water wetland, if 1 mile or less:

No fresh-water wetlands were found near the Hanford Site.

Reference 11

Distance to critical habitat of an endangered species or national wildlife refuge, if 1 mile or less:

Although there are several sensitive and threatened species that are residents of the Hanford Site (for at least part of the year), no endangered species are known to be residents of the site. Two threatened species, the bald eagle and the ferruginous hawk, are residents of the site (for at least part of the year). Because there are no endangered species (state or federal listing) that reside at the site, there is no critical habitat to be considered in the ranking of the 300 Area Site.

The Draft Phase I Installation Assessment of Inactive Waste-Disposal Sites at Hanford, Volume 1, July 1986 listed the Merriam's Shrew as being on the State Endangered Species List. This information was taken from a list published in a preliminary draft of an environmental impact statement, and, since the referenced February 1987 list shows the Merriam's Shrew as only a proposed sensitive species, it is assumed that the previous list taken from the preliminary draft is in error.

Reference 18

Population Served by Surface Water

Location(s) of water-supply intake(s) within 3 miles (free-flowing bodies) or 1 mile (static water bodies) downstream of the hazardous substance and population served by each intake:

The City of Richland drinking water intake is within 3 miles downstream of

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300 Area Site (considering that the boundary of the site reaches to river mile 43.8). The Richland intake is located at approximately river mile 46.4. The City of Richland population is 33,578. The 300 Area also has an intake (312 Intake) from the river. The 312 Intake is located within the border of the 300 Area Site (considering that the boundary of the site reaches to river mile 43.8). The population served by the 300 Area intake (300 Area workers) is 3110.

The population of Kennewick, Washington, is also considered because the Richland City Water Supply has an emergency water intertie to the Kennewick Water Supply System. The population of Kennewick is 34,387.

The Tri-Cities University Center has an intake from the river, which is used for irrigation. The estimated population affected by the Tri-Cities University Center irrigation water intake is 240.

The Battelle Farm Operations utilizes a river intake for irrigation water that is within 3 miles of the 300 Area Site. The estimated population affected by the Battelle Farm Operations irrigation water intake is 252.

Reference 6, page 2.10; Reference 17; Reference 20, page 3; Reference 16; Reference 11; Reference 12; Reference 21

Computation of land area irrigated by above-cited intake(s) and conversion to population (1.5 people per acre):

The land area irrigated by the Tri-Cities University Center is estimated to be 160 acres. Using the 1.5 people per acre criteria the population affect is estimated to be:

160 acres (1.5 people/acre) = 240

Reference 17

The Battelle Farm Operations RRC well is located within 3 miles of the site. The farm operations draw water from the well and from the river to irrigate the forage crops that are grown. The PNL irrigation operations cover a total of 168 acres. Using the 1.5 people per acre criteria, this results in an affected population of:

168 acres (1.5 people/acre) = 252

Reference 12; Reference 11

Total population served:

The total population served is calculated by summing all the respective population estimates:

33,578 + 34,387 + 240 + 252 = 68,457

This total does not include the 3110 300-Area workers since they would also be counted in the City of Richland and City of Kennewick numbers. This will avoid double counting of populations.

Name/description of nearest of the above water intakes:

The nearest water intake would be the 312 Intake located at the 300 Area. This intake serves the 3110 workers of the 300 Area. It is used for drinking water as well as process water.

Reference 16; Reference 20, page 3; Reference 21

Distance to above-cited intakes, measured in stream miles.

The 312 Intake is located within the border of the 300 Area Site (considering that the boundary of the site reaches to river mile 43.8). Thus, the distance to the intake is 0 miles.

Reference 14, page 18; Reference 16; Reference 20, page 3; Reference 21

AIR ROUTE

1 OBSERVED RELEASE

Contaminants detected:

Even though air concentrations of some of the constituents of interest can be detected above background offsite, not air monitoring data were found sufficient for HRS scoring of the Hanford CERCLA sites. These constituents of interest detected above background offsite are present in the routine gaseous effluents from operating facilities at Hanford. Therefore, the air route rating factors were not scored.

Date and location of detection of contaminants:

Not Applicable

Methods used to detect the contaminants:

Not Applicable

Rationale for attributing the contaminants to the site:

Not Applicable

2 WASTE CHARACTERISTICS

Reactivity and Incompatibility

Most reactive compound:

Not Applicable

Most incompatible pair of compounds:

Not Applicable

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Toxicity

Most toxic compound:

Not Applicable

Hazardous Waste Quantity

Total quantity of hazardous waste:

Not Applicable

Basis of estimating and/or computing waste quantity:

Not Applicable

3 TARGETS

Population Within 4-Mile Radius

Circle radius used, give population, and indicate how determined:

0 to 4 mi   0 to 1 mi   0 to 1/2 mi   0 to 1/4 mi

Not applicable

Distance to a Sensitive Environment

Distance to 5-acre (minimum) coastal wetland, if 2 miles or less:

Not applicable

Distance to 5-acre (minimum) fresh-water wetland, if 1 mile or less:

Not Applicable

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Distance to critical habitat of an endangered species, if 1 mile or less:

Not Applicable

Land Use

Distance to commercial/industrial area, if 1 mile or less:

Not Applicable

Distance to national or state park, forest, or wildlife reserve, if 2 miles or less:

Not Applicable

Distance to residential area, if 2 miles or less:

Not Applicable

Distance to agricultural land in production within past 5 years, if 1 mile or less:

Not Applicable

Distance to prime agricultural land in production within past 5 years, if 2 miles or less:

Not Applicable

Is a historic or landmark site (National Register or Historic Places and National Natural Landmarks) within the view of the site?

Not Applicable

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FIRE AND EXPLOSION

1 CONTAINMENT

Hazardous substances present:

Not scored

Type of containment, if applicable:

* * *

2 WASTE CHARACTERISTICS

Direct Evidence

Type of instrument and measurements:

Ignitability

Compound used:

Reactivity

Most reactive compound:

Incompatibility

Most incompatible pair of compounds:

* * *

9 1 3 2 1 8 . 0 7 2 4

Hazardous Waste Quantity

Total quantity of hazardous substances at the facility:

Basis of estimating and/or computing waste quantity

* * *

3 TARGETS

Distance to Nearest Population

Distance to Nearest Building

Distance to Sensitive Environment

Distance to wetlands:

Distance to critical habitat:

Land Use

Distance to commercial/industrial area, if 1 mile or less:

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Distance to national or state park, forest, or wildlife reserve, if 2 miles or less:

Distance to residential area, if 2 miles or less:

Distance to agricultural land in production within past 5 years, if 1 mile or less:

Distance to prime agricultural land in production within past 5 years, if 2 miles or less:

Is a historic or landmark site (National Register or Historic Places and National Natural Landmarks) within the view of the site:

Population Within 2-Mile Radius

Buildings Within 2-Mile Radius

DIRECT CONTACT

1 OBSERVED INCIDENT

Date, location, and pertinent details of incident:

Not scored

* * *

2 ACCESSIBILITY

Describe type of barrier(s):

* * *

3 CONTAINMENT

Type of containment, if applicable:

* * *

4 WASTE CHARACTERISTICS

Toxicity

Compounds evaluated:

Compound with highest score:

* * *

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5 TARGETS

Population within one-mile radius

Distance to critical habitat (of endangered species)

HRS DOCUMENTATION LOG SHEET

SITE NAME U.S. DOE Hanford 300 Area
CITY Benton County STATE WA
IDENTIFICATION NUMBER

REFERENCE NUMBER	DESCRIPTION OF THE REFERENCE
1	300 Area General Layout Map, January 1987
2	Hanford Wells, PNL-5397, February 1985
3	Raw data sheets showing uranium analysis
4	Purification of Uranium by IBMK (HEXONE) Extraction,
	UST-RD-PM-9-80, January 1986
5	Hanford Ground Water Data Base printouts for uranium conc.
6	Draft Phase I Installation Assessment of Inactive Waste
	Disposal Sites at Hanford, Volume 1, July 1986
7	Environmental Monitoring at Hanford for 1986, PNL-6120,
	May 1987
8	Draft Phase I Installation Assessment of Inactive Waste-
	Disposal Sites at Hanford, Volume 2, July 1986
9	Uncontrolled Hazardous Waste Site Ranking System; A Users
	Manual, 40 CFR 300, Appendix A
10	Memo to file from KH Cramer on August 6, 1987 regarding
	Personal Communication with Michael Gillum, City of Richland,
	concerning Richland Water System (info, maps and data sheets)
11	U.S.G.S. Maps Showing 300 Area Surroundings
12	Battelle Farm Operations Drawings RC-486 and RC-1147
13	Disposal of Hanford Defense High-Level Transuranic and
	Tank Wastes, March 1986, DOE/EIS-0113, Volume 1

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HRS DOCUMENTATION LOG SHEET

SITE NAME U.S. DOE Hanford 300 Area
CITY Benton County STATE WA
IDENTIFICATION NUMBER

REFERENCE NUMBER	DESCRIPTION OF THE REFERENCE
14	Investigation of Ground Water Seepage from the Hanford
	Shoreline of the Columbia River, PNL-5289, November 1984
15	Reference not used.
16	Drawing H-3-53734 (showing 300 Area River Intake)
17	Memo to file from WS Weygandt regarding Personal Conversation
	with F Trent concerning TUC irrigation intake, August 12,1987
	including note to file from RD Stenner on October 29, 1987,
	concerning Crops Grown on the TUC 160 Acres
18	Endangered and Threatened Wildlife and Plants, 50 CFR,
	Part 17, Subpart B, October 86
19	Memo to file from BW Mercer regarding Franklin County
	Drinking Water Wells, August 25, 1987
20	Hanford Reservation Area Workers Census, BNWL-2298, July 1977
21	Memo to file from WS Weygandt regarding Personal
	Communication with R. B. Hall concerning the 312 River Water
	Intake for 300 Area, August 13, 1987
22	Letter from RD Stenner to DM Bennett on October 14, 1987,
	regarding ground water contaminant plumes
23	Memo to file regarding recreational use of the Columbia River
	from DR Sherwood, August 26, 1987

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HRS DOCUMENTATION LOG SHEET

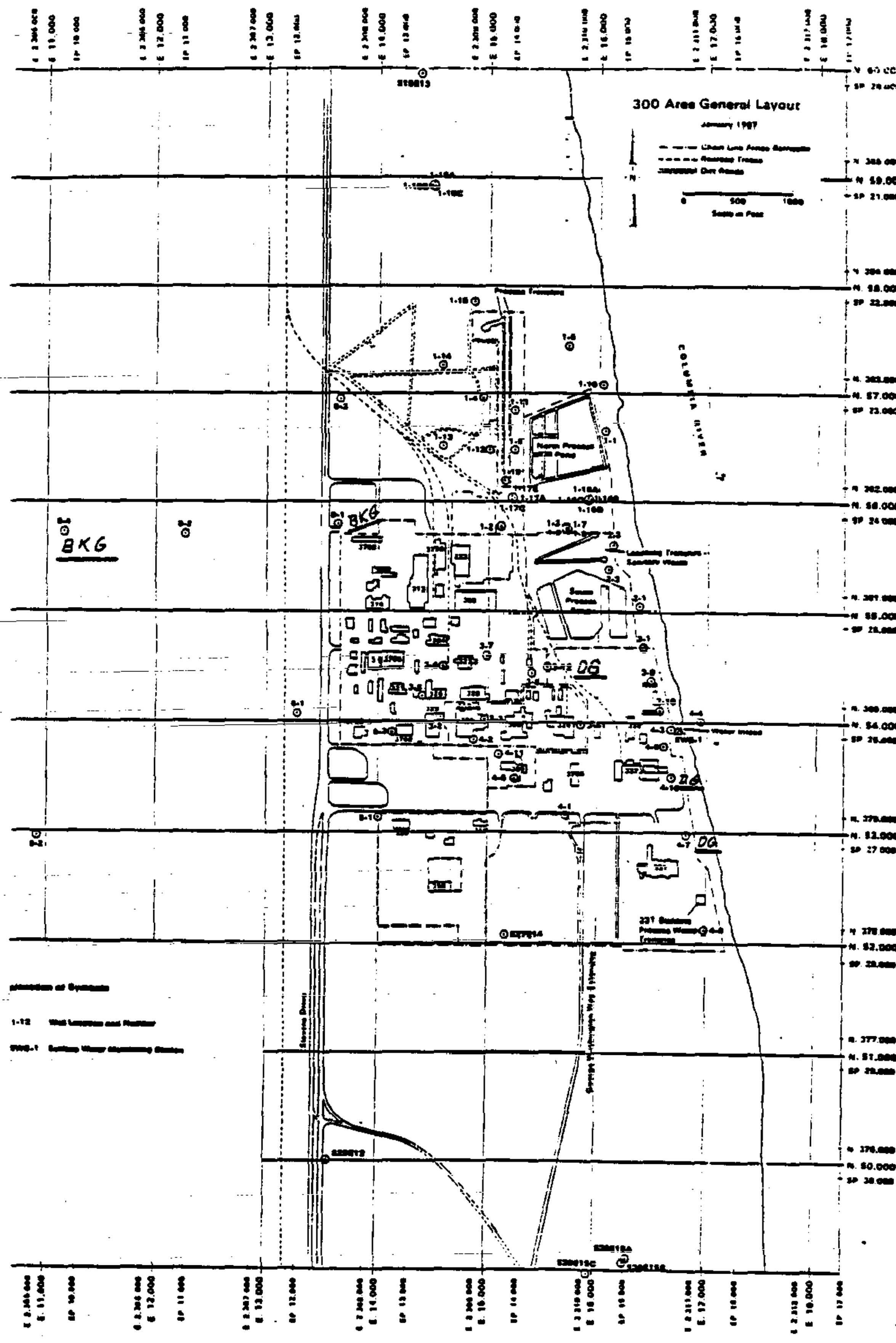
SITE NAME U.S. DOE Hanford 300 Area
CITY Benton County STATE WA
IDENTIFICATION NUMBER

REFERENCE NUMBER	DESCRIPTION OF THE REFERENCE
24	Letter from RD Stenner to DM Bennett regarding liquid waste
	sites and burning pits, October 26, 1987
25	Waste Management Operations, Hanford Reservation, ERDA-1538
	December 1975
26	Geology and Hydrology of Radioactive Solid Waste Burial
	Grounds at the Hanford Reservation, Washington, USGS 1976
	open file: 075-625
27	File note from RD Stenner to file on December 2,1987,
	regarding Landfill Operations
28	Memo from Kathleen Galloway, MITRE, to Sandy Crystall,EPA.
	December 29, 1987.

9413243.0073

REFERENCE 1

300 Area General Layout Map, January 1987


300 Area General Layout
January 1987
Columbia River
North Process
South Process
Process Trenches
237 Sanitary Process Waste Trenches
BKG
DG
Water Intake
Stevens Drive
George Washington Way Extension
Explanation of Symbols
1-12 Well Location and Number
SWS-1 Surface Water Monitoring Station
0 500 1000
Scale in Feet

Ref. 1.1

REFERENCE 2

<u>Hanford Wells</u>, PNL-5397, February 1985

PNL-5397
UC-11

9413218.0735

HANFORD WELLS

V. L. McGhan
P. J. Mitchell
R. S. Argo

February 1985

Prepared for
U.S. Department of Energy
Under Contract DE-AC06-76-RLO 1830

Pacific Northwest Laboratory
Richland, Washington 99352

Ref. 2.1

WELL NUMBERING SYSTEM

Well structures are identified by the number 99. The rest of the number designating a specific well is established mainly by its location on the plant. The designation includes three groups of symbols. The first group, applicable to wells in all locations, consists of the number 99 preceded by a number identifying the area in which the well is located. Example: 199, 299, 399, 499, 699, 1199, 3099.

100 AND 200 AREAS

Wells located in the 100 and 200 Areas are further identified in the second group of symbols according to the designation of the particular area (E, W, B, D, K, F, H, N), followed by the number of the sheet map encompassing that portion of the area in which the well is located. The sheet maps are shown on official second level maps for each area. Example: The first two-symbol groups for a well located within the area described by Sheet Map 24 of the 200 E Area would be 299-E24-. The 100 K Area and the 100 N Area second level maps are not further divided into sheet maps; thus the second group of symbols for these areas is simply "K" and "N." The third-symbol group in the well number identifies the specific structure within the sheet map area. In some cases the numbering system is arbitrary; but where practical, numbers were chosen in accordance with a previous numbering system. For example, the well formerly designated 361-8-6 now has the number 299-E28-6.

Some of the monitoring wells in the 200 Areas are dry wells, i.e., wells that do not extend to the water table. These have been differentiated from deeper wells by numbering all of the shallow wells with the third-group numbers greater than 50. In some cases wells have been designated with 100 and 200 Area numbers even though they are actually located outside the area fence. These structures are monitoring wells adjacent to ground disposal facilities that are located outside the area. Monitoring wells adjacent to the BC-Cribs are examples of this situation.

300 AREA

Wells in the 300 Area are designated in a manner similar to that described for the 100 and 200 Areas. The single difference occurs in the second symbol group in which no area designation is given, but which consists simply of the 300 Area sheet map number.

400 AREA

Most of the wells in the 400 Area were drilled before construction started and were included in the 600 Area numbering system. Well numbers in this area are now prefixed by 499. The second and third groups of numbers are plant coordinates and are explained in the next paragraph.

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600 AREA

The 600 Area includes all of the Hanford Site outside the limited access areas. Well numbers in this area are prefixed by 699. The second and third groups of numbers for 600 Area wells consist of the north and west plant coordinates, respectively, rounded off to the nearest 1,000 ft. For example, a well located at plant coordinates N25665, W14554 would be designated 699-26-15. If the well is located south or east of the plant coordinate origin, an S or E is used with the appropriate number. Some 600 Area wells are located within 1,000 ft of each other; these have letters (A, B, C, etc.) following the numbers for unique identification. A few wells located outside of the Hanford Site boundaries have also been given 600 Area designations.

1100 AND 3000 AREA

Well numbers in the 1100 Area (City of Richland) and the 3000 Area (old North Richland) have 1199 and 3099 prefixes, respectively. The second and third number groups are the Richland coordinates rounded to the nearest 1,000 ft. These wells were located in the Richland coordinate system because the plant grid had not been extended this far south when they were surveyed. New wells within the Hanford Site boundaries in the 1100 and 3000 Areas are located and named in the 600 Area plant grid system. However, wells drilled since 1961 within the Richland city limits are not included in the listing.

WELL DESIGNATION ---------- EMA NO.	COORDINATES	CASING ELEV. (FT-MSL)	DRILL DEPTH (FT)	INIT. DEPTH (FT) TO WATER	DIA. (IN)	DEPTH TO BOTTOM (FT)	MIN-MAX PERFORATED DEPTH (FT)	DATE COMP. (M-Y)	FORMER DESIGNATION	COMMENTS
399 3 4	N 054140 R E 014800	402.00	40		8.0	40		5-51	300-3 T.H.	CASING REMOVED
399 3 5	N 054250 R E 014430	390.00	40		8.0	40		5-51	300-4 T.H.	CASING REMOVED
399 3 6 3031	N 054514 R E 014600	390.25	85		10.0	85		8-43	300-D1W 3905-1	
399 3 7 4839	N 054600 R E 015000	380.31	86		12.0	86		1-44	300-D2W 3905-2	
399 3 8 4706	N 054449 R E 015400	387.50	40	43	8.0		20 - 40	3-70		SAMPLE PUMP
399 3 9 4626	N 054399 R E 016490	387.35	70	45	8.0	70		8-76		020 SCREEN 45-55 FT. SAMPLE PUMP
399 3 10 4627	N 054117 R E 016370	385.66	67	39	8.0	67		9-76		SAMPLE PUMP, SCREEN
399 3 11 4628		393.91	72	47	8.0	72		9-76		SAMPLE PUMP, SCREEN
399 3 12 4070			65	46	6.0			9-80		SAMPLE PUMP
399 4 1 4410	N 053162 R E 015723	392.10	101	50	8.0	96	25 - 80	2-51	303-10	SAMPLE PUMP
399 4 2	N 053060 R E 014900	402.00	41		8.0	42		5-51	300-1 T.H.	CASING REMOVED
399 4 3 4615	N 053960 R E 016700	372.00	100		8.0	100	NONE	4-58		CASING REMOVED

WELL DESIGNATION / EMA NO.	COORDINATES	CASING ELEV. (FT-MSL)	DRILL DEPTH (FT)	INIT. DEPTH (FT) TO WATER	DIA. (IN)	DEPTH TO BOTTOM (FT)	MIN-MAX PERFORATED DEPTH (FT)	DATE COMP. (M-Y)	FORMER DESIGNATION	COMMENTS
399 4 4	N 054021 R E 016953	370.00	40		6.0	40		5-50		CASING REMOVED
399 4 5 4402	N 053500 R E 015250	402.00	196	50	12.0	196	110-195	8-50		ARTESIAN WELL
399 4 6		390.00	134		8.0	134		7-50		CASING REMOVED
399 4 7 4560	N 052999 R E 016802	370.82	155	36	8.0	80	21 -150	11-61		SAMPLE PUMP PLUG AT 80
399 4 8 4809	N 052123 R E 017004	382.84	72	41	6.0	72	35 - 53	9-71		
399 4 9 4629	N 053019 R E 016399	381.26	65	32	8.0	65		9-76		020 SCREEN 30-50 FT. SAMPLE PUMP
399 4 10 4630	N 053527 R E 016471	377.00	40		8.0			9-76		SAMPLE PUMP, SCREEN
399 5 1 4411	N 053179 R E 014026	395.63	102	53	8.0	95	23 -100	2-51	303-11	SAMPLE PUMP
399 5 2 4575	N 053337 R E 011393	398.75	424	9	8.0	417	NONE	7-54	303-13	CONFINED AQUIFER
399 5 3	N 053930 R E 014170	394.00	36		8.0	36		5-51	300-2 T.H.	CASING REMOVED
399 6 1 4409	N 054003 R E 013300	386.98	101	44	8.0	67	25 - 75	5-50	303-9	SAMPLE PUMP
399 8 1 4405	N'055000 R E 013657	394.87	102	55	8.0	90	35 - 83	4-50	303-5	SAMPLE PUMP

WELL DESIGNATION / EMA NO.	COORDINATES	CASING ELEV. (FT-MSL)	DRILL DEPTH (FT)	INIT. DEPTH (FT) TO WATER	DIA. (IN)	DEPTH TO BOTTOM (FT)	MIN-MAX PERFORATED DEPTH (FT)	DATE COMP. (M-Y)	FORMER DESIGNATION	COMMENTS
399 0 2 R 4408	N 055710 E 012242	396.07	119	53	8.0	95	43 -106	5-50	303-8	SAMPLE PUMP PLUG AT 95 FT.
399 0 3 R 4412	N 056940 E 013535	393.21	102	50	8.0	99	25 - 99	3-51	303-12	SAMPLE PUMP
399 0 4 P 4065	S 023719 E 009610	393.00	65	45	6.0	65	42 - 60	9-79		SAMPLE PUMP

REFERENCE 3

Raw Data Sheets Showing Uranium Analysis

9413218.0742

Unfilt. #	LOCATION	DATE	pCi/L	pCi/L	± ERR pCi/L	pCi/L	± ERROR	Cr ppb	F⁻ ppm	NO3 ppm	U pCi/L	pCi/L		Co pCi/L
4444	699-39-79	1-22-86 / 8108		3.2+02	4.1+02					6.5				15±20
(Y) 4483	-55-50C			1.3+03	4.2+02					9.2				15±20
4547	-66-23									80				
4559	-20-39	1-21-86		2.1+02	4.1+02					15				18 ±17
4416	699-24-33	1-23-86 / 8109		4.1+04						58				-8.8 ±6.4
4638	-54-34			6.9+02	4.1+02					22				
4462	699-57-29A	1-24-86 / 8113		5.7+02	4.2+02					14				
4556	699-67-98			-3.9+02	4.0+02					18				
3034	399-3-3	1-29-86 / 8114	12 ±14	9.9+02	4.1+02			1.9	0.27	28	12±3.2			6.3 ±9.0
4401	-3-1		12 ±14	-1.3+02	4.1+02			0.21	0.33	44	8.9±2.6			-8.4 ±6.2
4403	-1-1		22 ±15	-1.1+02	4.1+02			2.3	0.41	43	17±4.0			-9.4 ±14
4407 ~~4409~~	-1-4		3.1 ±14	-2.3+02	4.1+02			2.5	0.40	42	12±3.0			-20 ±28
(Y) 4410	-4-1		20 ±15	1.0+02	4.1+02			2.9	0.32	37	19±4.1			15 ±20
DG 4568	-4-7		31 ±15	7.8+02	4.2+02			1.9	0.42	44	42±5.5 DG			-22 ±27
(Y) 4628	-3-11		15 ±14	4.5+02	4.2+02	6.9	1.8	0.53	0.40	31	18±4.0			15 ±10
4806	-1-5		13 ±14	1.7+01	4.1+02			2.4	0.50	39	27±4.1			-20 ±34
(Y) 4837	-1-6		6.5 ±14	-1.5+02	4.1+02			2.1	0.34	42	12±3.5			15 ±20

* SPECIFIC ION ELECTRODE

Ref. 3.1

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	EMA	LOCATION	DATE	B pCi/l	3 ± Error pCi/l		Sr pCi/l	± Error	Cr+6 ppb	F ppm	NO_3 ppm*	U pCi/l	pCi/l	pCi	60Co pCi/l	α pCi/l
BKG	4405	399-8-1	2-20-86 8147	5.0±14	2.3+02	4.1+02			0.74	0.27	36	6.6±2.3			-5.5 ±4.7	
	4409	-6-1		2.5±14	2.9+02	4.1+02			3.0	0.25	69	9.2±3.2			-4.6 ±5.3	
①	4411	-5-1		25±14	1.3+02	4.1+02			2.9	0.24	120	51±5.8			15 ±22	
①	4412	-8-3		4.3±14	6.2+02	4.1+02			2.0	0.34	30	31±4.9			15 ±20	
①	4626	-3-9		16±14	2.5+02	4.1+02	1.9	1.1	1.6	0.35	46	7.7±2.5			8.2 ±7.8	
DG	4630	-4-10		19±14	9.2+02	4.2+02	1.8	1.1	2.2	0.38	43	32±5.0	DG		1.1 ±7.2	
BKG	4865	-8-4		15±14	2.3+02	4.1+02			2.3	0.43	52	5.1±2.1	BKG		7.7 ±21	
DG ①	4870	-3-12		19±14	1.7+03	4.3+02	1.3	1.0	3.2	0.29	43	30±4.9	DG		8.0 ±19	
	4420	699-08-32	2-21-86 8148		3.2+02	4.1+02					22					
	4424	-S-12-03			2.7+02	4.1+02					30					
	4513	-01-18			5.5+04						53					
	4526	-02-33A0			1.3+02	4.1+02					17					
	4788	-08-25			4.2+04						51				20 ±25	
X	4833	-11-01A			5.5+02	4.1+02	Audit Sample				17					
	4502	499-S-06E-04B	2-21-86 8149		2.4+04	6.3+02					48	4.6±2.0				
	4504	S-06E-04D			3.5+04						60	4.7±2.7				
	4553	S-03E-12			4.0+03	4.5+02					57					

Ref. 3.2

REFERENCE 4

<u>Purification of Uranium by IBMK (HEXONE) Extraction,</u>

UST-RD-PM-9-80, January 1986

PURIFICATION OF URANIUM BY IBMK (HEXONE) EXTRACTION

Principles and Limitations

Uranium, as tetrapropylammonium uranyl trinitrate, is extracted from an acidic solution of acid deficient aluminum nitrate and tetrapropylammonium hydroxide with isobutylmethyl ketone (IBMK). Less than 1% of the one-year-cooled fission products are extracted. Most anions, with the exception of tungstate and ferrocyanide in high mole ratios to uranium do not affect the extraction. Americium, curium, and neptunium do not extract to any appreciable extent, whereas plutonium as Pu(VI) will extract. The Uranium is recovered by back extraction into water while evaporating the ketone. Chemical recoveries are determined using standard uranium or U-232 yield monitors.

Literature References

Booman, G. L., and Rein, J. E., "Uranium," Treatise on Analytical Chemistry, edited by I. M. Kolthoff and P. J. Elving, Part II, Volume 9, Inter-Science Publishers, New York, 1962, pp 1-188.

Maeck, W. J., Booman, G. L., Elliott, M. C., and Rein, J. E., "Separation of Uranium from Diverse Ions," Anal. Chem., Volume 30, 1958, p 1902.

Nietzel, O. A. and de Sesa, M. A., "Spectrophotometric Determination of Uranium with Thiocyanate," Anal. Chem., 29, 1957, p. 756.

Reagents

All reagents are prepared from analytical reagent grade chemicals. Class I D.I. water is used throughout this procedure.

16M HNO_3 - stock reagent.

30% Hydrogen peroxide.

10% Tetrapropylammonium hydroxide.

2M HNO_3 - Pour 125 mL of 16M HNO_3 into D.I. water and dilute to 1 liter.

Isobutylmethyl ketone - stock reagent. Also called hexone and IBMK.

Ruthenium Dye - 2 grams ruthenium trichloride hydrate dissolved and diluted to 1 liter with D. I. water.

2.8M $Al(NO_3)_3$ Salting Solution, 1M Acid Deficient:

1. Place 1050 grams (2.31 lb) $Al(NO_3)_3 \cdot 9H_2O$ into a 2 liter beaker.

2. Dilute to 900 mL with D. I. Water. Warm until dissolved.

3. Add 67.5 mL of concentrated NH_4OH (ammonium hydroxide) and stir for several minutes until the hydroxide precipitate dissolves.

4. Cool to less than 50 degrees C and dilute approximately to the 1 liter mark with D. I. Water.

5. Remove any uranium contamination by placing the salting solution in a 2 liter separatory funnel, adding about 200 mL of IBMK and shaking manually for 5 minutes. Drain the salting solution back in the 2 liter beaker. Drain the IBMK to a 400 mL beaker containing 25 mL D.I. water.

6. Check the solution for uranium contamination by evaporating the IBMK to dryness. Plate on 1 1/2" dish and count 50 minutes for possible alpha contamination. After reviewing the data, your supervisor will determine whether the salting solution is ready for use or if it is necessary to repeat step 5. A count rate less than ten times the background would indicate further decontamination of the salting solution unnecessary. This is based on a 90% decontamination efficiency.

7. Add 10 mL of tetrapropylammonium hydroxide and stir until dissolution is complete.

<u>Equipment and Materials</u>

8 position stirring unit

1 1/2 or 2 inch magnetic stir bars

beakers: 50, 100 or 250-mL

heat lamp

Two liter beaker and separatory funnel for reagent purification

Procedure

*Refer to procedure 30-BA-SP for Bioassay Samples or 30-ENV-SP for Environmental Samples for the appropriate bioassay or environmental sample preparation procedure.

1. Boil the solution from a sample preparation procedure to near dryness or until solids start forming. If the sample becomes dry or solidified, add 1 mL (or more as necessary) of 2M HNO_3.

2. Add 10 mL of $Al(NO_3)_2$ salting solution for each 1-2 mL of sample. The salts from 100 mL of urine can be dissolved/suspended in about 1 mL of 2M HNO_3. Example: Sample volume is ~3 mL. Use 20 mL of $Al(NO_3)_2$ salting solution.

3. Add 1 mL ruthenium dye and one teflon coated magnetic stirring bar.

   KEY POINT: The ruthenium dye assists in determining phase separation. Ruthenium remains in the aqueous phase (lower layer) and is black in color. The organic (upper layer) phase should be colorless.

4. Add 10 mL of IBMK (hexone) and stir for five minutes on a magnetic stirrer.

5. Remove the beaker from the stirrer and allow the phases to separate.

   KEY POINT: If the phases won't separate within 10 minutes, separation can be achieved by centrifuging.

6. Carefully pour most of the IBMK (upper layer) into a labeled 50 mL beaker. At least 90% of IBMK can be poured off in this way.

   KEY POINT: If any bottom layer goes into the 50 mL beaker, remove it with a pipet and transfer to the original beaker, or recombine the layers and try the separation again.

7. Add a second 10 mL of IBMK and stir for 2-3 minutes.

Repeat steps 5 and 6, combining with the first IBMK.

8. Place the 50 mL beakers under a heat lamp in the order of increasing sample identification number and fill each beaker to the 40 mL mark with D. I. Water. Evaporate to dryness.

KEY POINT: 1. Arranging the beakers in order will avoid any error in case the IBMK removes any identification from the beaker.

2. Water helps to control the temperature. IBMK can boil under heat lamp temperatures. When this happens, the sample will turn yellow in color and dry to a dark residue. Wet-ash with a few mL 16M HNO_3 and a few drops of 30% H_2O_3.

9. Depending on the type of uranium analysis requested on the sample, proceed to one of the following three procedures:

a) Only Uranium Isotopic is Requested - Proceed to the Electrodeposition Procedure, 30-ED-02.

b) Only Natural Uranium requested - Proceed to "Fluorometic Determination of Uranium," 20-U-03 or "Determination of Uranium by Kinetic Phosphorescance Analysis", 20-U-05.

L A S T   P A G E

APPROVED FOR USE [signature] 1/31/86
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FLUOROMETRIC DETERMINATION OF URANIUM FOLLOWING PURIFICATION

Principles and Limitations

The residue from the Uranium Purification Procedures (20-U-01) or (20-U-02) is dissolved for fluorometric determination of total uranium. The method involves fusion of the sample in a sodium and lithium fluoride flux at 1750°F and measurement of the yellow-green uranium fluorescence using a fluorophotometer. To adjust for interferences and to quantify the sample reading, a known amount of natural uranium is added to a duplicate aliquot and measured similarly. The fluorometric method can be affected by sample matrix interferences such as quenching agents (i.e., iron) and fluorescent agents (i.e. organics).

Literature References

Booman, G.L. and Rein, J.E., "Uranium", Treatise on Analytical Chemistry, edited by I.M. Kolthoff and P.J. Elving, Part II, Vol. 9, Interscience Publishers, New York, 1962, pp. 1-188.

Reagents

2M HNO_3

Flux for Fluorometric Uranium Determination

1. Add 9.1 g fluorometric grade lithium fluoride to a 1 pound (454g) bottle of fluorometric grade sodium fluoride. Seal the bottle and mix overnight on a rolling mixer.

2. Check the prepared flux by fusing 5 blanks and 5 spikes containing known quantities of uranium and read on a fluorometer prior to use.

3. Spikes should read within 10% of normal values. Blanks are expected to read less than 0.0050.

Equipment and Materials

Beakers, 1-L and 250-mL
Covered metal racks for holding platinum dishes
Platinum dishes

9413216.0751

Pipet - 100 uL, 200 uL
Pipet tips
Pelletizer
Fused-pellet fluorometric equipment

Calculations - Uranium Radiometric Yield

dpc = counting efficiency as disintegration per count

Y = sample yield = (cpm)(dpc)/(dpm uranium added to the spike sample)

Calculations - Uranium Fluorometric

SAM = Sample reading

BL = Blank reading

SP = Spike plus sample reading

SPC = Spike value in micrograms per mL

Y = Radiometric spike yield. Use Y = 1.0 if result is not to be yield corrected

V_T = Total sample volume

V_A = Sample volume analyzed

V_R = Volume of 2M HNO_3 to dissolve residue (step 1). Use 4 mL for DOE bioassay samples, 10 mL for all others.

V = Aliquot of V_R

$$\frac{SAM - BL}{SP - SAM} \times \frac{SPC\ (0.05\ mL)}{Y} \times \frac{V_R}{V} \times \frac{V_T}{V_A} = \text{ug U/sample}$$

This calculation may be used for solid sample by dividing by sample weight in grams.

Section A: Quality Control

1. Quality control checks are to be performed every day that samples are to be analyzed by the fluorometric procedure.

2. Set up the platinum dishes on a covered metal rack, placing 4 low-level dishes and 3 spike dishes in two

separate rows.

KEY POINT: The extra low-level dish is for the blank sample. The spike dishes should be in the front row. The rows are separated to minimize cross-contamination.

3. Add exactly 100 uL (microliters) of QC #1 to a low-level dish and to the spike dish.

4. Repeat Step #3 for QC #2 and QC #3 spikes.

5. Add exactly 50 uL of natural uranium standard to each spike dish.

6. Add 100 uL of 2M HNO_3 to every dish.

7. Place the rack supporting the samples under a heat lamp.

8. Prepare a Fluorometric Analysis Sheet as shown in Procedure #60-23-01 and below:

Sample vol. 100 uL
Spike vol. 50 uL
Spike conc. (value on bottle)
Fusion time 3 minutes

9. Remove the QC rack from under the heat lamp when the dishes are dry. After the QC samples are measured take the data to your supervisor for evaluation. Go to Section C, Fluorometric Analysis.

Section B: Sample Dissolution and Uranium Radiometric Yield

1. To the residue from a uranium purification procedure, add exactly 10 mL (4 mL for DOE bioassay samples) of 2M HNO_3. Swirl to effect dissolution.

NOTE: If the results are to be yield-corrected, go to step 2. If not proceed to Section C.

2. Transfer exactly 1 mL to a previously labeled 1.5 inch s.s. planchet and dry under a heat lamp. Go to Section C, Fluorometric Analysis.

3. Count the planchet for 50 minutes with an alpha proportional counter to determine the U-232 tracer yield.

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Section C: Fluorometric Analysis

1. Analyze Hanford DOE and RMI urine samples in duplicate (two spike dishes and two low-level dishes for each sample). Others: one spike, one low-level dish per sample.

2. Set up platinum dishes for the samples on a rack. Place a corresponding spike dish in front of each low-level dish. Add one extra low-level dish for the blank after each set of four samples.

3. Pipet 50 uL of uranium standard containing about 10 micrograms uranium per milliliter into each spike dish.

4. Swirl the sample solutions well and pipet 200 uL (100 uL for ERA samples) into each set of spike and non-spike dishes per sample. Maintain identification by a mapped arrangement.

5. Place the sample rack under a heat lamp and slowly take all dishes to dryness.

6. Prepare to fuse the samples on the fusion wheel as follows:

   a. Turn on the air purifier.
   b. Turn on the burner exhaust fan.
   c. Open the air valve.
   d. Open the gas tank valve several turns.
   e. Light the burners.
   f. Adjust the burners to obtain the desired flame.

7. Place a NaF-LiF flux pellet on each dish.

8. Place the dishes on the fusion wheel in a sample-spike, sample-spike order, and set the timer for three minutes. The fusion temperature is regulated between 1750 and 1780 degrees F. Each sample is fused twice. Retain dish identification by maintaining a consistent order throughout the fusing and reading process.

9. While the samples are fusing, set up the fluorometer as follows:

   a. Open the light shutter, which is kept closed when not measuring samples.

   b. Set the reading at zero on all scales.

   c. Set the #8 position standard to read 5.

KEY POINT: It is necessary to push the middle button on the digital readout if "OL" appears on the display.

d. The #9 position standard should read less than .0025. If it is above .0025, the fluorometer may need service. Consult your supervisor.

e. Recheck the zero.

10. Remove the samples to the metal racks after they have cooled from the second fusion.

11. Prepare the analysis sheet by recording the sample number, volume of sample analyzed, volume of uranium spike used, strength of uranium spike initials of technician, date of analysis and any other comments pertinent to the analysis. See section 60-23 for instructions.

12. Transfer each sample to the platinum dish holder in the fluorometer, close the cover, move sample into position, and record the dial reading on the analysis sheet.

13. After reading the sample, remove the platinum dish from the fluorometer, discard the pellet, and place the platinum dishes in its appropriate "low-level" or "spike" beaker.

14. Add about 200 mL of 16M HNO_3 to each 1 liter beaker containing the platinum dishes. Place on an oscillating hot plate and boil for about 1 hour. Remove and allow to cool. Decant the HNO_3 acid to a cup sink with running water. Rinse with D.I. water liberally and decant to the sink.

KEY POINT: Allow the tap water to run in the sink for at least five minutes to dilute the acid.

15. Repeat step 11.

16. Add about 200 mL of D.I. water to each beaker and place on hot plate again and allow to boil for 30 minutes. Decant D.I. water and rinse twice with D.I. water. Remove as much water as possible and transfer dishes to 250 mL beakers labeled appropriately. The platinum dishes are now ready for re-use.

LAST PAGE

APPROVED FOR USE [illegible] 1/31/86

William McLaidy 1/31/86

Al Robinson 1/31/86

REFERENCE 5

Printouts of Uranium Concentration from Hanford Ground Water Data Base

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NOTE: REMOTE USER: PNLW::D38836_VGBD

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THE RECORDS ARE VARIABLE LENGTH WITH IMPLIED (CR) CARRIAGE CONTROL. THE LONGEST RECORD IS 0 BYTES.

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Ref. 5.1

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3-3-12	4/24/86	K	104		2.7000E+01	8	
3-3-12	7/15/86	K	104		2.2000E+01	8	
3-3-12	10/10/86	K	104		4.4000E+01	8	
~~3-4-7~~	~~1/29/86~~	~~K~~	~~104~~		~~4.2000E+01~~	~~8~~	D6 DRL
3-4-7	4/10/86	K	104		2.2000E+01	8	
3-4-7	7/14/86	K	104		2.3000E+01	8	
3-4-7	11/10/86	K	104		4.7000E+01	8	

Uranium is constituent code 104

Ref. 5.2

9413218.0758

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NOTE: Remote Users  PIL:::D3003u+VGDD

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Ref. 5.3

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3-8-1	2/20/86	CR+6		7.4000E-04	B	
3-8-1	2/20/86	FLORIDE		2.7000E-01	B	
3-8-1	2/20/86	NO3-ION		3.6000E+01	B	
3-8-1	2/20/86	TRITIUM		2.3000E+02	B	
3-8-1	2/20/86	U		6.6000E+00	B	BKG
3-8-4	2/20/86	BETA		1.5000E+01	B	
3-8-4	2/20/86	CO 60		7.7000E+00	B	
3-8-4	2/20/86	CR+6		2.3000E-03	B	
3-8-4	2/20/86	FLORIDE		4.3000E-01	B	
3-8-4	2/20/86	NO3-ION		5.2000E+01	B	
3-8-4	2/20/86	TRITIUM		2.3000E+02	B	
3-8-4	2/20/86	U		5.1000E+00	B	BKG

Ref. 5.4

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Earth Sciences Computer Center

NOTE: Remote User: PHLUS::D3893uevGAD

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N   N  EEEEE    T    P      R   R   III   N   N    T
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Digital Equipment Corporation - VAX/VMS Version V4.5

Ref. 5.5

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	LESS THAN FLAG	ANALYSIS VALUE	ANALYSIS SPONSOR
3-8-1	2/20/86	BETA		5.8000E+00	B
3-8-1	2/20/86	CO 60		-5.5000E+00	B
3-8-1	2/20/86	CR+6		7.4000E-04	B
3-3-1	2/20/86	FLORIDE		2.7000E-01	B
3-8-1	2/20/86	NO3-ION		3.6000E+01	B
3-8-1	2/20/86	TRITIUM		2.3000E+02	B
3-8-1	2/20/86	U		6.6000E+00	B
3-3-4	2/20/86	BETA		1.5000E+01	B
3-8-4	2/20/86	CO 60		7.7000E+00	B
3-8-4	2/20/86	CR+6		2.3000E-03	B
3-8-4	2/20/86	FLORIDE		4.3000E-01	B
3-8-4	2/20/86	NO3-ION		5.2000E+01	B
3-8-4	2/20/86	TRITIUM		2.3000E+02	B
3-8-4	2/20/86	U		5.1000E+00	B
3-4-10	2/20/86	BETA		1.9000E+01	B
3-4-10	2/20/86	CO 60		1.1000E+01	B
3-4-10	2/20/86	CR+6		2.2000E-03	B
3-4-10	2/20/86	FLORIDE		3.8000E-01	B
3-4-10	2/20/86	NO3-ION		4.3000E+01	B
3-4-10	2/20/86	SR 90		1.8000E+00	B
3-4-10	2/20/86	TRITIUM		9.2000E+02	B
3-4-10	2/20/86	U		3.2000E+01	B

D6

Ref. 5.6

REFERENCE 6

Draft Phase I Installation Assessment of Inactive Waste Disposal Sites at Hanford, Volume 1, July 1986 portion of the 300 Area by rainwater is therefore highly improbable. There are no natural streams or watercourses other than the Columbia River within or adjacent to the 300 Area.

Ground water enters the 300 Area from the northwest, west, and southwest and flows into the Columbia River. Throughout most of the 300 Area, the ground water flows toward the east and southeast. Only in the southern portion of the area does the ground water flow in a northeasterly direction. The water table generally slopes downward from west to east; depth to ground water is from 10 to 15 meters (34 to 48 ft). Variations in the river level, ground-water withdrawal from area wells, and discharge of waste water to the process ponds and leaching trenches cause variations in the level of the water table.

The residence nearest the 300 Area is approximately 1.5 kilometers (0.9 mi) east across the Columbia River. A number of irrigated farms are located just across the river from the 300 Area. The northern part of Richland, lying within about 4 kilometers (2.5 mi) of the 300 Area, is an industrial park. The nearest residences in Richland are about 4.6 kilometers (2.9 mi) from the 300-Area boundary. The nearest city water intake is the Richland pumping station, 6 kilometers (3.7 mi) downstream from the 300 Area.

Most of the facilities in the 300 Area, completed in 1943 and the years immediately following, were used to support the fabrication of reactor fuel. The activities here included many technical and service support functions, as well as fuel manufacturing. As the Hanford production reactors were shut down, fuel-manufacturing activities decreased and other activities increased. Thus, for over 15 years, research and development programs have constituted a major part of the activities in the 300 Area. The newer facilities mostly house laboratories and large test facilities in support of peaceful uses of plutonium, reactor-fuels development, liquid-metal technology, fast-flux test facility support, gas-cooled reactor programs, and life-sciences programs.

Fuel elements are fabricated by a coextrusion process. This process forms the zirconium cladding and the uranium-silicon fuel core from primary material components and bonds the two together in one operation. The fuel elements are protected with a copper jacket for the extrusion process. The

Ref. 6.1

jacket also prevents atmospheric contamination of the reactive fuel element, and the copper is easily lubricated for extrusion. Lubricants are removed using organic solvents such as trichloroethylene. After extrusion into billets, the copper is removed by dissolution into nitric acid. The uranium core is recessed by chemical milling so that the billets can receive an end cap. The chemical milling is performed using copper sulfate, nitric acid, and sulfuric acid. A zirconium end cap is then brazed on with beryllium. The fuel elements are tested for cap attachment, cap to core bonding, cladding to core bonding, and cladding to cap bonding before fuel-element supports and locking clips are attached. Next, the tubes are autoclaved for 72 hours in 360°C (680°F) steam to detect any perforations in the cladding or end caps. Finally, the elements are packaged for storage and shipment.

The 300 Area contains a number of support facilities, including a convertible oil/coal powerhouse for process steam production, raw-water intake, treatment, and storage, and other facilities necessary to support fuels production, research, and development. Slightly more than 3,000 workers are employed in the 300 Area (Yandon 1977).

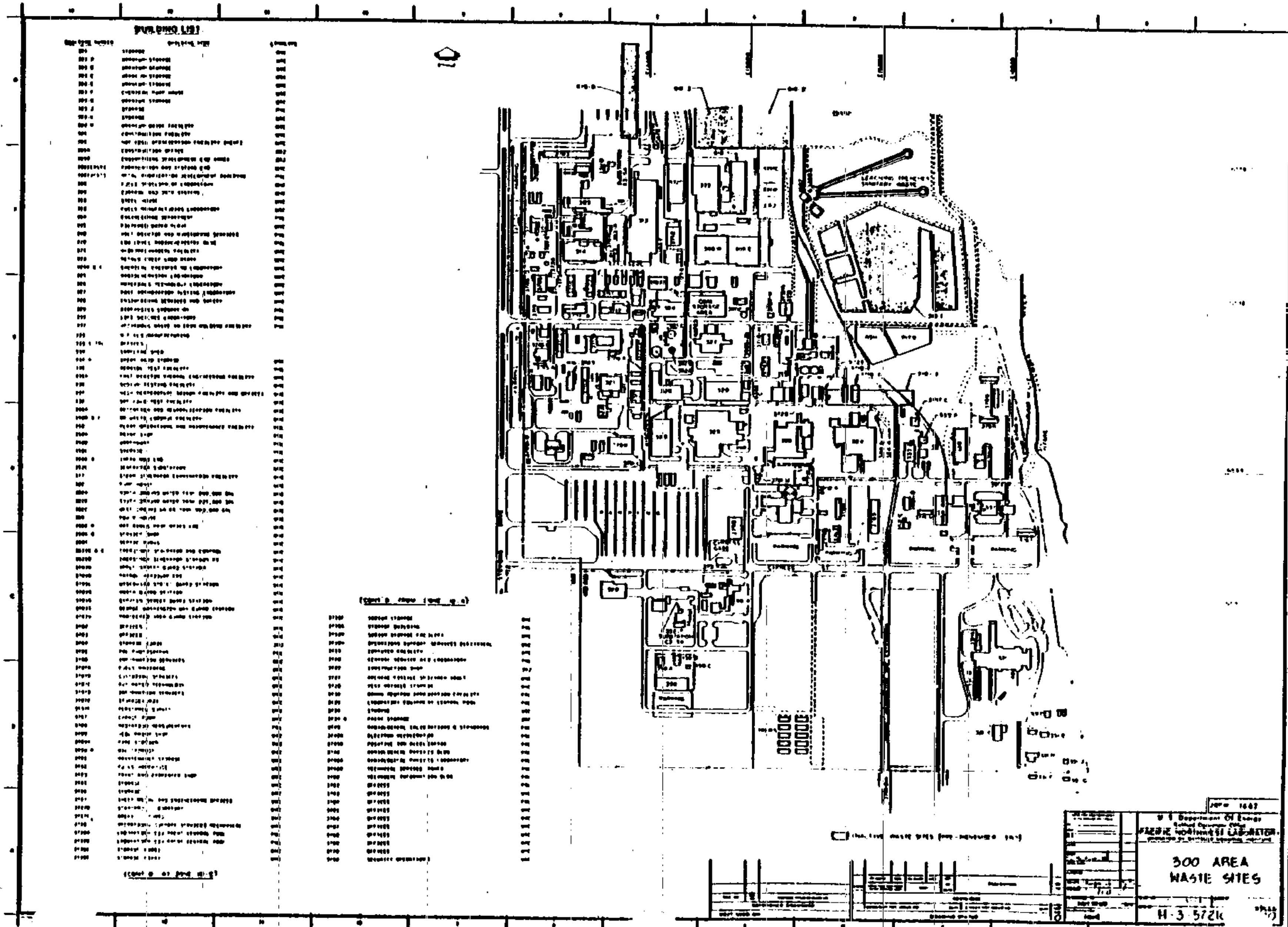
2.3.4 400 Area

The 400 Area is a controlled area of about 0.5 square kilometer (130 acres) located in the southeast part of the Hanford Site; it is approximately 7.2 kilometers (4.5 mi) from the Columbia River and 6.2 kilometers (3.9 mi) from the nearest Site boundary.

The area is located at an elevation of about 170 meters (558 ft) above MSL. The land around the site slopes gently away to the south and east toward the Columbia and Yakima rivers. The site is devoid of prominent topographic features.

The glaciofluvial deposits upon which the 400 Area is located extend from the surface to a depth of about 45 meters (148 ft). The surface sediments are coarse sands merging into the coarse Pasco gravels. The water table beneath the 400 Area is in the upper part of the Ringold Formation, at a depth of about 50 meters (164 ft).

Ref. 6.3



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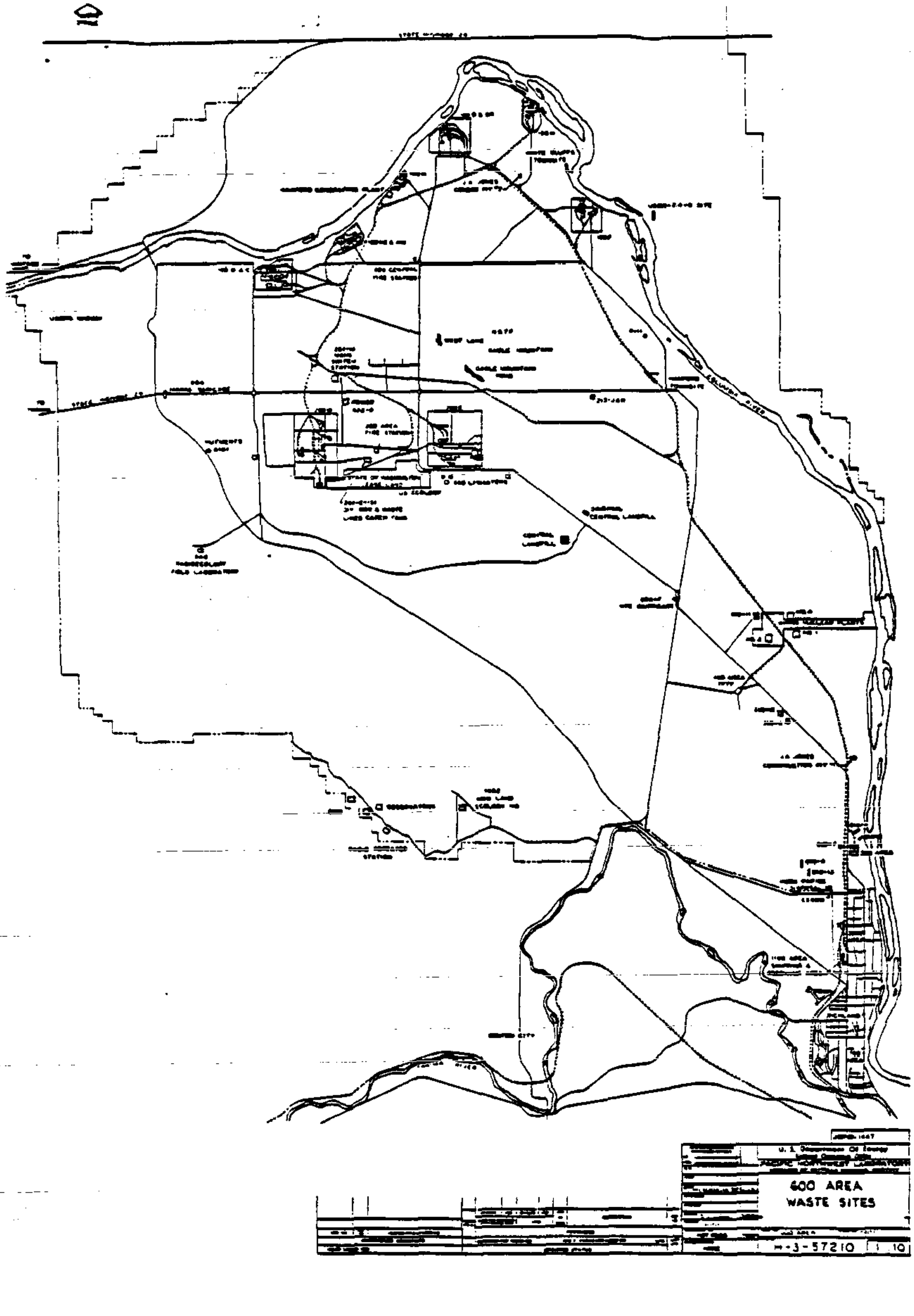

Ref. 6.4

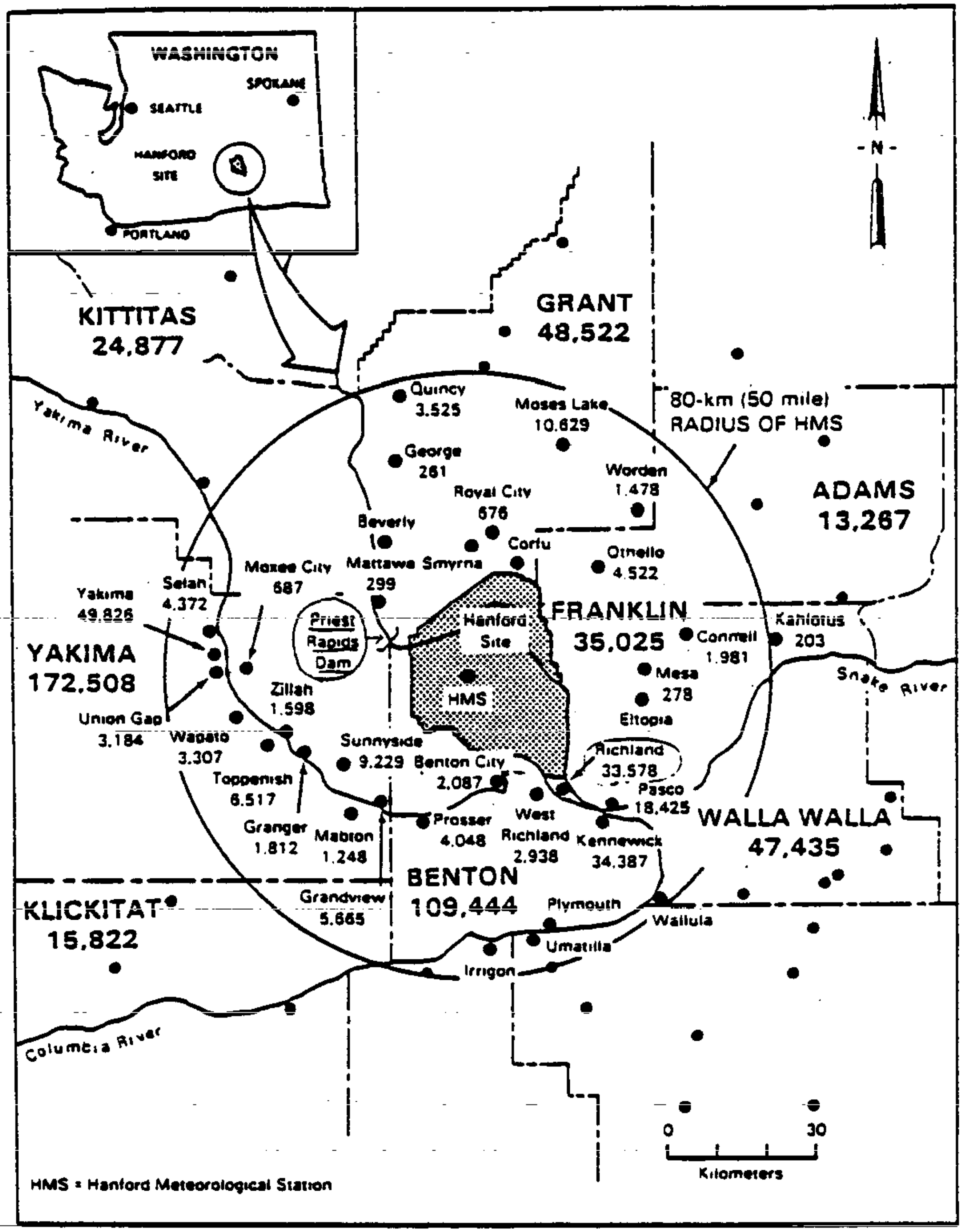

FIGURE 2.4. U.S. Census Populations for 1980 of Cities Within 80 Kilometers of the Hanford Meteorological Station (U.S. DOE 1986)

Ref. 6.5

REFERENCE 7

<u>Environmental Monitoring at Hanford for 1986</u>,

PNL-6120, May 1987

2.0. BACKGROUND INFORMATION

2.1. DESCRIPTION OF THE HANFORD SITE

K. R. Price, P. J. Mitchell, and M. D. Freshley

The U.S. Department of Energy's Hanford Site is located in a rural region of southeastern Washington and occupies an area of 1,500 km^2. The Site (shown in Figure 2.1) lies about 320 km northeast of Portland, Oregon, 270 km southeast of Seattle, Washington, and 200 km southwest of Spokane, Washington. The Columbia River flows through the northern edge of the Hanford Site and forms part of the eastern boundary. The southern boundary of the Site includes the Rattlesnake Hills, which exceed 1000 m in elevation. Both confined and unconfined aquifers are present beneath the Site. The main geologic units are the Columbia River Basalt Group, the Ringold Formation, and a series of glaciofluvial sediments. The Hanford Project was established in 1943 and was originally designed, built, and operated to produce plutonium for nuclear weapons.

SURFACE CHARACTERISTICS OF THE SITE

The semiarid land on which the Hanford Site is located has a sparse covering of desert shrubs and drought-resistant grasses. The most broadly distributed type of vegetation on the Site is the sagebrush/cheatgrass/bluegrass community. Most abundant of the mammals is the Great Basin pocket mouse. Of the big-game animals, the mule deer is the most abundant, while the cottontail rabbit is the most abundant of the small-game animals. Coyotes are also abundant. The bald eagle is a regular winter visitor to the relatively large areas of uninhabited land comprising the Hanford Site.

The Columbia River, which originates in the mountains of eastern British Columbia, Canada, flows through the northern edge of the Hanford Site and forms part of the Hanford Site's eastern boundary. The river drains a total area of approximately 70,800 km^2 enroute to the Pacific Ocean. The flow of the Columbia River is regulated by 11 dams within the United States, 7 upstream and 4 downstream of the Site. Priest Rapids Dam is the nearest impoundment upstream of the Site, and McNary Dam is the nearest dam downstream. (The Hanford reach of the Columbia River extends from Priest Rapids Dam to the head of Lake Wallula, which is created by McNary Dam.) This is the only stretch of the Columbia River within the U.S. that is not impounded by a dam. The width of the river varies from approximately 300 m to about 1000 m. The flow through this stretch of the river is relatively swift, with numerous bends and several islands present throughout the reach.

The flow rate of the Columbia River in this region is regulated primarily by Priest Rapids Dam. Hanford reach flows fluctuate significantly because of the relatively small storage capacity and operational practices of the nearby upstream dams. A minimum flow rate of 1,000 cubic meters per second (m^3/s) [36,000 cubic feet per second (cfs)] has been established at Priest Rapids. Typical daily flows range from 1,000 m^3/s (36,000 cfs) to 7,000 m^3/s (250,000 cfs) with peak spring runoff flows of up to 12,600 m^3/s (450,000 cfs) being recorded. Typical annual average flows at Priest Rapids Dam are 3,100 m^3/s (110,000 cfs) to 3,400 m^3/s (120,000 cfs). Monthly mean flows typically peak from April through June and are at the lowest levels from September through October.

The temperature of the Columbia River varies seasonally. Minimum temperatures are observed during January and February while maximum temperatures typically occur during August and September. Monthly temperatures for the river range from approximately 3°C to about 20°C during the course of a year. Water storage management practices at upstream dams and the flow rate of the river dictate, to a large extent, the thermal characteristics of the Columbia River along the Hanford reach.

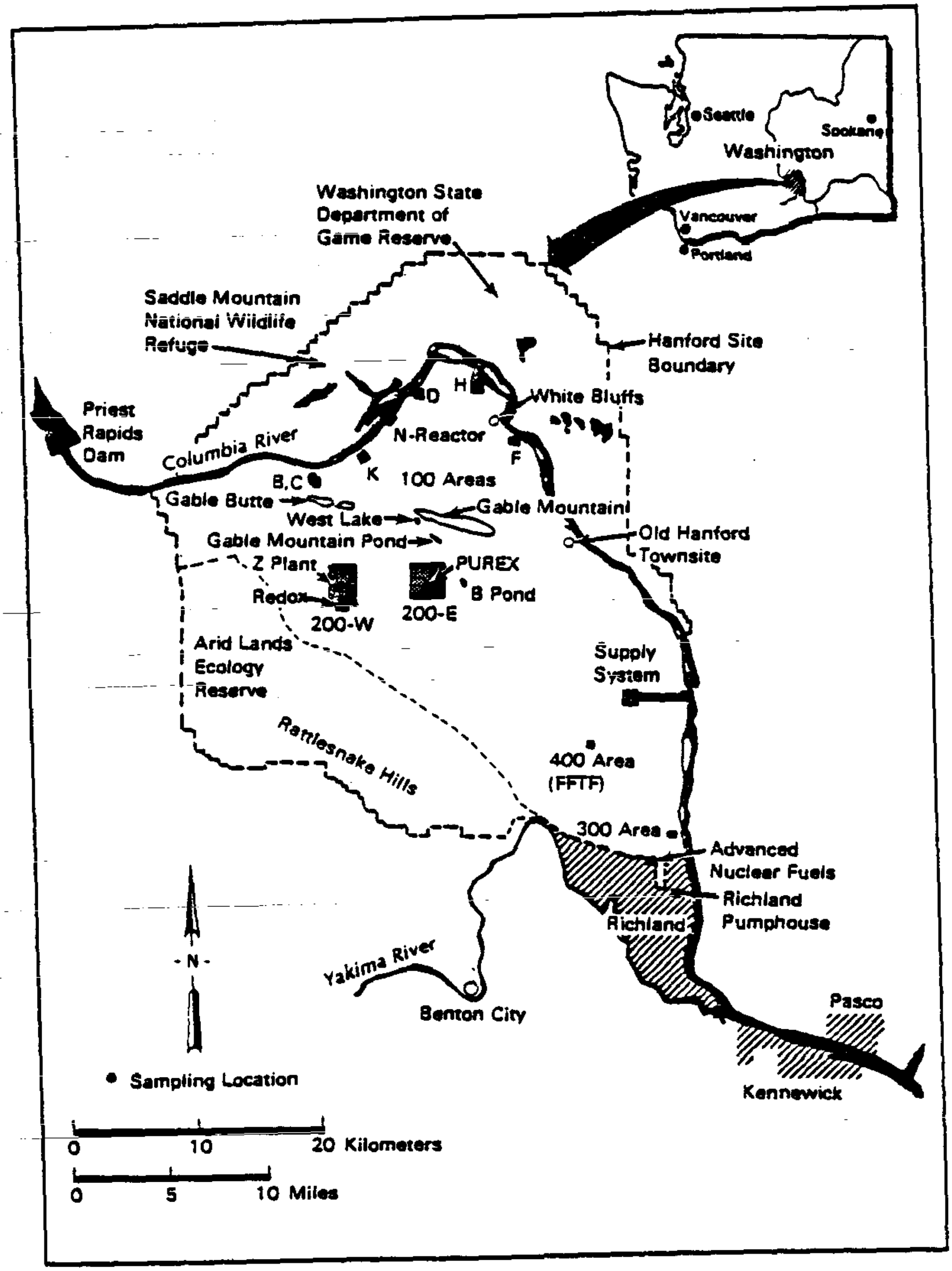

FIGURE 2.1. DOE's Hanford Site

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Ref. 7.2

The Columbia River system has been developed extensively for hydroelectric power, flood control, navigation, irrigation, and municipal and industrial water supplies. In addition, the Hanford reach is used for a variety of recreational activities including fishing, hunting, boating, water skiing, and swimming. The State of Washington has classified the stretch of the Columbia River from the Washington-Oregon border to Grand Coulee Dam (which includes the Hanford reach) as Class A and established water quality criteria and water use guidelines for this class designation. Because these criteria do not include specific limits for radionuclides, Environmental Protection Agency (EPA) and State of Washington drinking water limits were used for comparison. Other surface water on the Site consists of West Lake (a small, natural pond) and a number of ditches and artificial ponds created for routine disposal of waste water.

Hanford's climate is dry and mild; the area receives approximately 16 cm of precipitation annually. About 40% of the total precipitation occurs during November, December, and January; only 10% falls in July, August, and September. Approximately 45% of all precipitation from December through February is snow. The average minimum and maximum temperatures in July are 16°C and 32°C. For January, the average temperatures are 3°C and -6°C.

Monthly average wind speeds range from about 10 km/h in the summer to 14 km/h in the winter. The prevailing regional winds are from the northwest, with occasional cold-air drainage into valleys and occurrences of strong crosswinds. The region is a typical desert area with frequent strong inversions that occur at night and break during the day, resulting in unstable and turbulent wind conditions.

Land near the Hanford Site is primarily used for agriculture and for livestock grazing. Agricultural lands are found north and east of the Columbia River and south of the Yakima River. These areas contain orchards, vineyards, and fields of alfalfa, wheat, and vegetables. The Hanford Site north of the Columbia River is shared between a state wildlife management area and a federal wildlife refuge. The northeast slope of the Rattlesnake Hills along the southwestern boundary of the Site is designated as the Arid Lands Ecology Reserve (ALE) and is used for ecological research by DOE.

The major population center nearest to the Hanford Site is the Tri-Cities area (Richland, Pasco, and Kennewick), which is situated on the Columbia River downstream from the Site and has a population of approximately 90,000. Approximately 340,000 people live within an 80-km radius of the Hanford Site. This number includes people living in the Tri-Cities, the Yakima area, several small communities, and the surrounding agricultural area. More detail on Site characteristics and activities is available in "The Final Environmental Statement, Waste Management Operations, Hanford Reservation" (ERDA 1975).

SUBSURFACE CHARACTERISTICS OF THE SITE

The DOE operations on the Site have resulted in the production of large volumes of waste water that have historically been discharged to the ground through cribs, ditches, and ponds. These discharges greatly influence the physics and chemistry of the subsurface. Approximately 25 billion liters of liquid effluent in the 200 Areas and 2.6 billion liters of liquid effluent in the 100N Area were disposed to the ground during 1986, including process cooling water and water containing low-level radioactive wastes. The discharge of waste water to the ground at the Hanford Site began in the mid-forties and reached a peak in 1955. After 1955, discharge to cribs declined because of improved treatment of waste streams and the deactivation of various facilities (Graham et al. 1981). Since the restart of the Plutonium and Uranium Extraction (PUREX) Plant and related facilities in late 1983, discharge of PUREX-related effluents has resumed.

Subsurface structures, such as cribs, have primarily been used for the disposal of water containing radioactive wastes, while surface ponds and ditches have primarily been used for the disposal of uncontaminated cooling water (Graham et al. 1981). Sanitary wastes are discharged to the ground via tile fields. The majority of liquid disposal occurred in the Separations Area, which includes the 200-East (200E) and 200-West (200W) Areas (Figure 2.1). Smaller amounts of waste water were disposed in the 100 and 300 Areas. Discharges of waste water to the ground in the 400 Area were minimal.

Geologic and hydrologic properties of the subsurface, including stratigraphy and physical and chemical properties of the host rock, influence the movement of the liquid effluents. The geology and hydrology beneath the Site and the physical nature of liquid effluent movement are described in more detail in the following sections.

Geology

The main geologic units beneath the Hanford Site include, in ascending order, the Columbia River Basalt Group, the Ringold Formation, and a series of glaciofluvial sediments informally known as the Hanford formation. A generalized geologic cross section of the Site is shown in Figure 2.2.

The Columbia River Basalt Group is a thick series of basalt flows. The basalts have been warped and folded, producing anticlines that, in some places, crop out at the land surface. The Ringold Formation overlies the basalts except in some localized areas. This formation consists of fluvial and lacustrine sediments and is separated into four lithologic units: basal, lower, middle, and upper. The basal and middle units consist mostly of semiconsolidated gravels and sands, whereas the lower and upper units consist mainly of bedded silts and sands. Beneath the 200-West Area, sediments of the upper Ringold Formation have been reworked by the wind and deposited as a silt layer called the Palouse soil. The Hanford formation rests atop the Ringold Formation or Palouse soil. The Hanford formation also rests atop basalts in places where

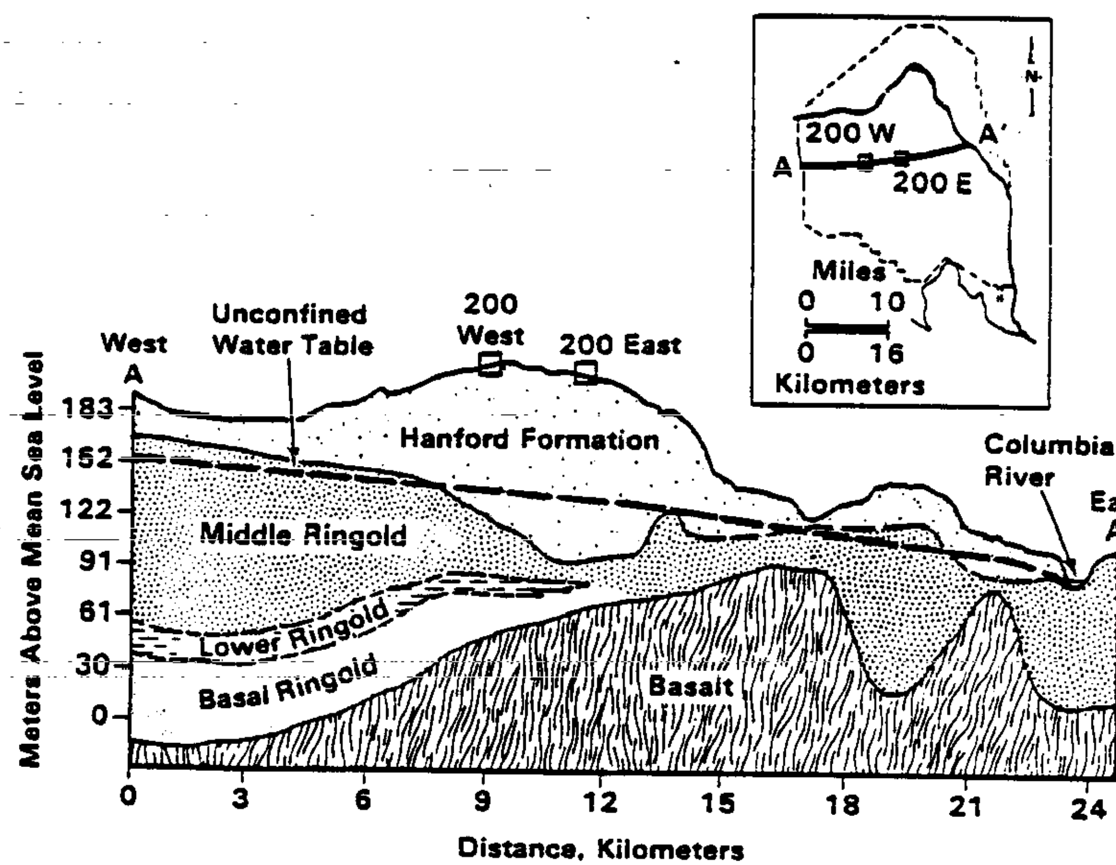

FIGURE 2.2. Geologic Cross Section of theSite (modified from Tallman et al. 1979)

Ref. 7.4

the Ringold formation has been removed. These sediments were deposited by the ancestral Columbia River when it was swollen by glacial meltwater. The glaciofluvial sediments consist primarily of gravels and sands, with some silts (Newcomb, Strand and Frank 1972).

Hydrology

Both confined and unconfined aquifers are present beneath the Hanford Site. The confined aquifers, in which the ground water is under pressure greater than that of the atmosphere, are found primarily within the Columbia River basalts. In general, the unconfined or water-table aquifer is located in the Ringold Formation and glaciofluvial sediments, as well as some more recent alluvial sediments in areas adjacent to the Columbia River (Gephart et al. 1979). This relatively shallow aquifer has been affected by waste-water disposal at Hanford more than the confined aquifers (Graham et al. 1981). Therefore, the unconfined aquifer is the most thoroughly monitored aquifer beneath the Site.

The unconfined aquifer is bounded below by either the basalt surface or, in places, the relatively impervious clays and silts of the lower unit of the Ringold Formation. Laterally, the unconfined aquifer is bounded by the anticlinal basalt ridges that ring the basin and by the Yakima and Columbia rivers. The basalt ridges above the water table have a low permeability and act as a barrier to lateral flow of the ground water (Gephart et al. 1979). The saturated thickness of the unconfined aquifer is greater than 61 m in some areas of the Hanford Site and pinches out along the flanks of the basalt anticlines. The depth from the ground surface to the water table ranges from less than 0.3 m near the Columbia River to over 106 m in the center of the Site. The elevation of the water table above mean sea level for June of 1986 is shown in Figure 2.3.

Recharge to the unconfined aquifer originates from several sources (Graham et al. 1981). Natural recharge occurs from precipitation at higher elevations and runoff from ephemeral streams to the west, such as Cold Creek and Dry Creek. The Yakima River recharges the unconfined aquifer as it flows along the southwest boundary of the Hanford Site. The Columbia River recharges the unconfined aquifer during high stages when river water is transferred to the aquifer along the river bank. The unconfined aquifer receives little, if any, recharge from precipitation directly on the Hanford Site because of a high rate of evapotranspiration under native soil and vegetation conditions. However, present studies, such as those described by Heller, Gee, and Meyers (1985), suggest that precipitation may contribute more recharge to the ground water than was originally thought.

Large scale artificial recharge occurs from offsite agricultural irrigation and liquid-waste disposal in the operating areas at Hanford. Recharge from irrigation in the Cold Creek Valley enters the Hanford Site as ground-water flow across the western boundary. Artificial recharge from waste-water disposal at Hanford occurs principally in the Separations Area. It was estimated that recharge to the ground water from facilities in the Separations Area (including B Pond and Gable Mountain Pond, as well as the various cribs and trenches in the 200W and 200E Areas) adds ten times as great an annual volume of water to the unconfined aquifer as is contributed by natural inflow to the area from precipitation and irrigation waters to the west (Graham et al. 1981).

The operational discharge of water has created ground-water mounds near each of the major waste-water disposal facilities in the Separations Area and in the 100 and 300 Areas (Figure 2.3). These mounds have altered the local flow pattern in the aquifer, which is generally from the recharge areas in the west to the discharge areas (primarily the Columbia River) in the east. Water levels in the unconfined aquifer have changed continuously during Site operations because of variations in the volume of waste water discharged. Consequently, the movement of ground water and its associated constituents has also changed with time.

In addition to the Separations Area, ground-water mounding also occurs in the 100 and 300 Areas. Ground-water mounding in these areas is not as significant as in the Separations Area because of differences in discharge volumes and subsurface geology. However, in the 100 and 300 Areas, water levels are also greatly influenced by river stage.

Liquid Effluent Movement

If significant quantities of liquid effluents are discharged to the ground at the Hanford Site waste disposal facilities, then these effluents would percolate downward through the unsaturated zone to the water table. As effluents move through the unsaturated zone, adsorption onto soil particles, chemical precipitation, and ion exchange delays the movement of some uncomplexed radionuclides, such as ^{90}Sr, ^{137}Cs, and $^{239,240}Pu$. Other ions, such as nitrate (NO_3), and radionuclides, such as ^3H, ^{129}I, and ^{99}Tc, are not retained by the soil as readily. These constituents move through the soil column at varying rates and eventually enter the ground water. Subsequently, the nonattenuated constituents move downgradient in the same direction as and at a rate nearly or often equal to the flow of ground water. As the constituents move with the ground water, radionuclide concentrations are reduced by spreading (dispersion) and radioactive decay.

MAJOR ACTIVITIES

Previously, the Hanford Site housed and operated up to nine production reactors, including eight with once-through cooling by treated river water. Between December 1964 and January 1971, all eight reactors with once-through cooling were deactivated. The N Reactor, which is the production reactor remaining in operation, has a closed primary cooling loop.

Four major DOE operating areas exist at the Hanford Site [i.e., 100, 200, 300, and 400 Areas (Figure 2.1)]. The 100 Areas include facilities for the N Reactor and the eight deactivated production reactors along the Columbia River. The reactor fuel reprocessing plant (PUREX), Plutonium Finishing Plant (Z Plant), and waste-management facilities are on a plateau about 11.3 km from the river, in the 200 Areas. The 300 Area, just north of the city of Richland, contains the reactor fuel manufacturing facilities and research and development laboratories. The Fast Flux Test Facility (FFTF) is located in the 400 Area, approximately 8.8 km northwest of the 300 Area.

Privately owned facilities located within the Hanford Site boundaries include the Washington Public Power Supply System (Supply System) Hanford generating station adjacent to N Reactor, the Supply System power reactor and office buildings, and a low-level radioactive-waste burial site operated by U.S. Ecology. The Advanced Nuclear Fuel Corp. (formerly Exxon) fuel fabrication facility is immediately adjacent to the Hanford Site.

Principal DOE operating contractors at Hanford during 1986 included the following:

Rockwell Hanford Operations (Rockwell) – responsible for fuel reprocessing, waste management, and Site support services, such as plant security, fire protection, central stores, and electrical power distribution.

Battelle Memorial Institute (BMI) – responsible for operating PNL for DOE. Pacific Northwest Laboratory activities include research and development in the physical, life, and environmental sciences; chemistry; and advanced methods of nuclear waste management. Pacific Northwest Laboratory is also responsible for environmental monitoring at the Site.

UNC Nuclear Industries (UNC) – responsible for fabricating N Reactor fuel, operating the N Reactor, and decommissioning formerly used DOE facilities, including deactivated production reactors.

Westinghouse Hanford Company (WHC)– responsible for operating the Hanford Engineering Development Laboratory (HEDL), including advanced reactor developments and the FFTF test reactor.

Hanford Environmental Health Foundation (HEHF) – responsible for occupational medicine and environmental health support services.

Operational Highlights

Highlights of operational activities at Hanford during 1986 were

- The N Reactor operated for 182 days, during which time it supplied steam used by the Supply System to generate 860 megawatts of electrical power. Since its startup, the N Reactor has supplied steam for the production of over 65 billion kilowatt-hours of electrical power, which has been supplied to the Bonneville Power Administration grid covering the Pacific Northwest.
- The PUREX Plant fuel reprocessing facility located in the 200E Area completed a third year of operation since restart of operations in 1983. The uranium oxide plant (UO_3 Plant) operated as needed through 1986. The Plutonium Reclamation Facility at Z Plant operated throughout the year as well.

Ref. 7.6

those wells with detectable amounts of ^{137}Cs, ^{103}Ru, ^{106}Ru, ^{125}Sb, or ^{131}I were listed in Tables A.16 through A.20. Cesium-137 was detected in only a few wells because of its low mobility in the ground water. All concentrations of ^{137}Cs were below the DWS (200 pCi/L) and DCG (3000 pCi/L). (See Appendix A, Table A.16, for a summary of ^{137}Cs results.)

Ruthenium-103 was detected in 100N-Area wells only. This constituent was not expected to be found beyond areas immediately adjacent to the 100N Area because of its short half-life (39.4 days). All concentrations in these wells were below the DCG (50,000 pCi/L). Results are summarized in Appendix A, Table A.17.

Ruthenium-106 is a mobile, short-lived gamma-emitter. In some instances, ^{106}Ru and ^{125}Sb made up a significant portion of the gross beta activity. Wells in the 100N Area near the 1325N LWDF showed average ^{106}Ru concentrations of 150 to 970 pCi/L, which is above the DWS (30 pCi/L) and below the DCG (6000 pCi/L). One 600-Area well (6-38-65, located between the 200E and 200W Areas) had a concentration of 560 ± 210 pCi/L. Results are summarized in Appendix A, Table A.18.

Antimony-125, an easily detected gamma-emitter, was measured in well I-K-27 and in the 100N-Area wells near the 1325N LWDF. Results ranged from 140 to 410 pCi/L, which is far below the DCG of 60,000 pCi/L (see Appendix A, Table A.19).

Because ^{131}I has a short half-life, it was also detected only in 100N-Area wells. The highest concentrations existed near the 1325N LWDF (17,000 to 330,000 pCi/L), which is significantly above the DWS (3 pCi/L) and the DCG (3000 pCi/L). (All wells analyzed for gamma emitters are listed in Table A.16.) Results are summarized in Appendix A, Table A.20.

The presence of ^{129}I in ground water is significant primarily because of its relatively long half-life (16 million years) and its potential for accumulation in the environment as a result of long-term releases from nuclear fuel reprocessing facilities (Soldat 1976). On the Hanford Site, the main contributor of ^{129}I to the ground water has been liquid discharges to cribs in the 200 Areas. Samples from six wells in the 200E Area and 12 wells in the 600 Area were analyzed for ^{129}I. Eight wells showed concentrations above the DWS for ^{129}I (1 pCi/L). (The DCG is 500 pCi/L.) Results of the ^{129}I analyses are listed in Appendix A, Table A.21.

Sources of uranium found in the ground water as a result of Site operations were liquid effluents placed in disposal cribs in the 200 Areas and in trenches in the 300 Area (ERDA 1975). Uranium may also occur naturally in soils, rock, ground water, and surface water (Fairbridge 1972). Uranium concentrations were measured in the unconfined aquifer in the vicinity of both the uranium fuel fabrication facilities and those inactive waste sites in the 300 Area known to have received uranium waste. As shown in Figure 3.17, a measurable uranium plume exists beneath the 300 Area. The extent of the uranium plume was limited to a fairly well-defined area downgradient from the active and inactive waste sites. Average annual uranium concentrations in the 300 Area ranged from 5 to 31 pCi/L (see Appendix A, Table A.22). These concentrations are similar to average concentrations measured in 1985.

Uranium concentrations in the 100H Area varied from extremely low levels (3.6 pCi/L) to an annual average of 460 pCi/L at well 1-H4-3. All 400- and 600-Area ground-water samples showed only background levels of uranium (less than 10 pCi/L) (Appendix A, Table A.23). Samples from six wells (6-39-0, 6-41-1, 6-42-2, 6-43-3, 6-46-4, and 6-47-5) along the Columbia River (in the area where tritium concentrations were highest) were analyzed for isotopic uranium (see Appendix A, Table A.23). The concentrations ranged from 1.8 to 2.2 pCi/L for ^{234}U, 0.035 to 0.057 pCi/L for ^{235}U, and from 1.2 to 1.8 pCi/L for ^{238}U. These levels were consistent with the gross alpha measurements taken in wells near the Columbia River and indicated that uranium was the dominant alpha-emitter in the six wells. The DCG for these three uranium isotopes are 500, 600, and 600 pCi/L, respectively.

Samples from the same six wells were analyzed for isotopic plutonium. Results are summarized in Appendix A, Table A.23. No detectable plutonium was observed, which is a further indication that the gross alpha activity predominantly resulted from uranium.

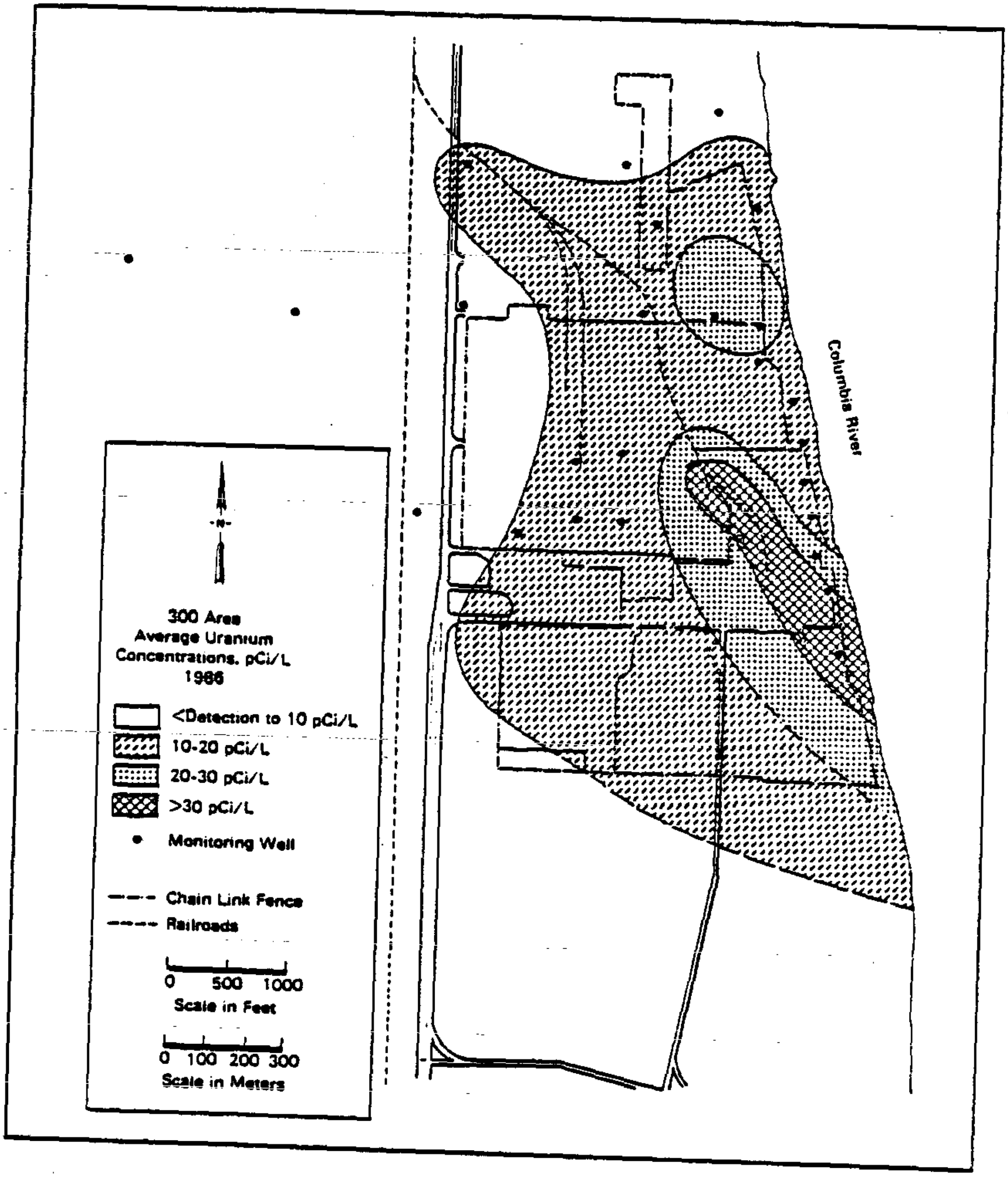

FIGURE 3.17. Uranium Concentrations in Ground Water Beneath the 300 Area for 1986 (see 300-Area location in Figure 3.10)

Ref. 7.8

9113218.0776

REFERENCE 8

Draft Phase I Installation Assessment of Inactive Waste-Disposal Sites at Hanford, Volume 2, July 1986

SITE ID NO.: 316-1

ALIAS: South Pond, 300 Area South Process Ponds
STATUS: Inactive
DIMENSIONS:
Length: 600 ft
Width: 375 ft
Depth: 9 ft
Diameter: 0 ft

FACILITY: Pond
ELEVATION: 376 ft
WATERTABLE: 34 ft

LOCATION: 300 Area
COORDINATES: N55225/E16250, N54750/E16280, N54713/E15584, N55200/E15441, N55387/E15789

SITE DESCRIPTION:

An 8 acre pond area containing 5 separate pond sections. Ponds 1, 2, & 3 are separated by two 30 ft. dikes, with the largest pond (No. 4) separated from 1, 2, & 3 (West side) by a 16 ft. dike and from Pond No. 5 (East side) by 100 ft. of land. The dikes were then bulldozed into 3 sections and the fill was used to cover loose material. In 1949 and 1953, the ponds were dredged and the sludge was removed and buried on the edge of the pond and the dikes.

SERVICE DATES: 1943-1975

SERVICE HISTORY:

From 1943 to 1975, the site received cooling water and low-level liquid wastes from fuel fabrication operations with incidental additional waste from the 3706 and 321 Buildings, wastes from the works Lab, organic wastes and water from 303 Area floor drains. The site was deactivated in 1975 and the pond has since dryed out.

REFERENCES:
Documents: HW-43121, HW-33305, DUN-3155
Photographs: 122440-268-CN
Drawings: H-3-57210, H-3-32708, H-3-53734, H-3-32585

Ref. 8.1

SITE ID NO.: 316-1

CHEMICALS DISPOSED

SODIUM:	2000000 kg	SODIUM ALUMINATE:	2000000 kg
SODIUM HYDROXIDE:	1000000 kg	NITRATE:	1000000 kg
NITRITE:	900000 kg	SODIUM SILICATE:	100000 kg
MERCURY:	60 kg	NICKEL (II):	10000 kg
CHROMIUM (VI):	5000 kg	ZINC (II):	5000 kg
CADMIUM (II):	80 kg	SILVER (I):	1000 kg
LEAD (II):	4000 kg	BERYLLIUM:	40 kg
FLUORIDE:	7000 kg	COPPER (II):	60000 kg
TRICHLOROETHYLENE:	100000 kg	METHYL ISOBUTYL KETONE:	0 kg
URANIUM:	40000 kg	NITRIC ACID:	1000000 kg

TOTAL VOLUME DISPOSED: 10000000000 Liters

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
MN-54:	0.00000	PM-147:	0.00000
CO-60:	0.00100	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.00000	NP-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.00000
ZR-95:	0.00000	PU-240:	0.00000
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00000
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.00000
CS-137:	0.00000	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

These values are decayed through April 1, 1986.

Ref. 8.2

SITE ID NO.: 316-2

ALIAS: North Pond, 300 Area North Process Ponds
STATUS: Inactive
DIMENSIONS:
Length: 620 ft
Width: 600 ft
Depth: 10 ft
Diameter: 0 ft

FACILITY: Pond
ELEVATION: 376 ft
WATERTABLE: 34 ft

LOCATION: 300 Area
COORDINATES: N57000/E15880, N56310/E16050, N56133/E15325, N56752/E15325

SITE DESCRIPTION:

This pond area consists of 7 separate sections separated by 12 ft. wide dikes, with the entire 10 acre area surrounded by a dike 15 ft. wide and approximately 10 ft. high. The pond has been dredged periodically to increase infiltration rate. Some subdividing dikes have been bulldozed to cover the pond bottom.

SERVICE DATES: 1949-1974

SERVICE HISTORY:

From 1949 to 1974 the site received low-level radionuclide liquid wastes and cooling water from 3706 and 321 Buildings, aqueous wastes containing unirradiated uranium from the Works Laboratory, and water from the floor drains in the 303 Area. The waste flowed through the 307 Retention Basin en route to the pond. The site was retired in 1974. The pond has since dryed out.

REFERENCES:
Documents: HW-43121, HW-33305, DUN-3155
Photographs: 122440-263-CN, 122440-264-CN, 122440-274-CN
Drawings: H-3-57210, H-3-32708, H-3-32585

SITE ID NO.: 316-2

CHEMICALS DISPOSED

SODIUM:	1000000 kg	SODIUM ALUMINATE:	2000000 kg
SODIUM HYDROXIDE:	800000 kg	NITRATE:	800000 kg
NITRITE:	700000 kg	SODIUM SILICATE:	90000 kg
MERCURY:	40 kg	NICKEL (II):	8000 kg
CHROMIUM (VI):	3000 kg	ZINC (II):	3000 kg
CADMIUM (II):	60 kg	SILVER (I):	900 kg
LEAD (II):	2000 kg	BERYLLIUM:	30 kg
FLUORIDE:	5000 kg	COPPER (II):	30000 kg
TRICHLOROETHYLENE:	100000 kg	METHYL ISOBUTYL KETONE:	0 kg
URANIUM:	30000 kg	NITRIC ACID:	900000 kg

TOTAL VOLUME DISPOSED: 10000000000 Liters

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
MN-54:	0.00000	PM-147:	0.05000
CO-60:	0.00100	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.00000	NP-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.00000
ZR-95:	0.00000	PU-240:	0.00000
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00000
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.00000
CS-137:	0.00000	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

These values are decayed through April 1, 1986.

Ref. 8.4

SITE ID NO.: 316-3

ALIAS: 307 Disposal Trenches
STATUS: Inactive
DIMENSIONS:
Length: 600 ft
Width: 10 ft
Depth: 20 ft
Diameter: 0 ft

FACILITY: Trench
ELEVATION: 393 ft
WATERTABLE: 43 ft

LOCATION: 300 Area
COORDINATES: N54265/E16000, N54185/E16000, N54185/E15475, N54265/E15475

9413218.0782

SITE DESCRIPTION:

Two parallel trenches 600 ft. x 10 ft. x 20 ft deep.

SERVICE DATES: 1953-1963

SERVICE HISTORY:

From 1953/54 to 1963 the site received wastes from the Works Laboratory Area (329 Biophysics Lab, 327 Radiometallurgy Bldg., 325 Radiochemistry Bldg, 326 Pile Technology Bldg) and sludge from 316-1 Pond. These wastes went through the 307 Retention Basin before releasing to the trenches. The site was retired in 1963 and the trenches filled in.

REFERENCES:
Documents: RHO-CD-673, HW-43121, HW-33305
Photographs: 122440-270-CN, 34631-3, 27854-8
Drawings: H-3-57210, H-3-32708, H-3-53734

SITE ID NO.: 316-3

CHEMICALS DISPOSED

SODIUM:	0 kg	SODIUM ALUMINATE:	0 kg
SODIUM HYDROXIDE:	0 kg	NITRATE:	0 kg
NITRITE:	0 kg	SODIUM SILICATE:	0 kg
MERCURY:	10 kg	NICKEL (II):	3000 kg
CHROMIUM (VI):	1000 kg	ZINC (II):	1000 kg
CADMIUM (II):	20 kg	SILVER (I):	300 kg
LEAD (II):	600 kg	BERYLLIUM:	10 kg
FLUORIDE:	2000 kg	COPPER (II):	20000 kg
TRICHLOROETHYLENE:	0 kg	METHYL ISOBUTYL KETONE:	0 kg
URANIUM:	10000 kg	NITRIC ACID:	0 kg

TOTAL VOLUME DISPOSED: 1000000000 Liters

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
MN-54:	0.00000	PM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.00000	NP-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.00000
ZR-95:	0.00000	PU-240:	0.00000
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00000
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.00000
CS-137:	0.00000	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

Although used for radioactive waste disposal, no inventory is available.

These values are decayed through April 1, 1986.

SITE ID NO.: 316-4

ALIAS: 321 Crib, 300 North Crib
STATUS: Inactive
DIMENSIONS:
 Length: 0 ft
 Width: 0 ft
 Depth: 10 ft
 Diameter: 8 ft

FACILITY: Crib
ELEVATION: 438 ft
WATERTABLE: 68 ft

LOCATION: 300 Area
COORDINATES: N6300/E3750

SITE DESCRIPTION:

Two approx. 8 ft. diameter, 7 ft. high, open bototm, 1/4 in. thick SS tanks buried 10 ft. below grade, resting on gravel strata. There is a waste influent line to the tanks starting at 2 ft. above the bottom of one of the tanks extending at an angle abobe the tank top to grade level. A vent riser extends from the top fo the same tank to 8 ft. above grade. The tanks are placed 2 ft. apart with SS overflow pipe connecting them just below the tops of the tanks.

SERVICE DATES: 1948-1956

SERVICE HISTORY:

From 1948 to 1956 the site received water contaminated with hexone bearing uranium wastes and limited amounts of other uranium bearing wastes from the 321 building. The site was retired sometime around 7/55 to 1956.

REFERENCES:
 Documents: RHO-CD-673, HW-43121, ARH-2164, HW-39076, HW-33305
 Photographs: 122440-260-CN, 122440-261-CN
 Drawings: H-3-57210, H-3-32708

Ref. 8.7

SITE ID NO.: 316-4

CHEMICALS DISPOSED

SODIUM:	0 kg	SODIUM ALUMINATE:	0 kg
SODIUM HYDROXIDE:	0 kg	NITRATE:	1000 kg
NITRITE:	0 kg	SODIUM SILICATE:	0 kg
MERCURY:	0 kg	NICKEL (II):	0 kg
CHROMIUM (VI):	0 kg	ZINC (II):	0 kg
CADMIUM (II):	0 kg	SILVER (I):	0 kg
LEAD (II):	0 kg	BERYLLIUM:	0 kg
FLUORIDE:	0 kg	COPPER (II):	0 kg
TRICHLOROETHYLENE:	0 kg	METHYL ISOBUTYL KETONE:	3000 kg
URANIUM:	2000 kg	NITRIC ACID:	0 kg

TOTAL VOLUME DISPOSED: 200000 Liters

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
MN-54:	0.00000	PM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.00000	NP-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.00000
ZR-95:	0.00000	PU-240:	0.00000
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00000
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.00000
CS-137:	0.00000	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

Although used for radioactive waste disposal, no inventory is available.

These values are decayed through April 1, 1986.

SITE ID NO.: 618-1

ALIAS: Solid Waste Burial Ground #1
STATUS: Inactive
DIMENSIONS:
Length: 320 ft
Width: 150 ft
Depth: 20 ft
Diameter: 0 ft

FACILITY: Burial Ground
ELEVATION: 390 ft
WATERTABLE: 48 ft

LOCATION: 600 Area
COORDINATES: N55310/W14987, N55360/W14987, N55310/W14834, N55630/W14834

SITE DESCRIPTION:

Burial ground consisting of at least two trenches running north-south, 16 ft. wide (surface) x 200 ft. long x 8 ft. deep. There are also a series of pits running east-west, 20 ft. deep and 15 ft. wide.

SERVICE DATES: 1945-1956

SERVICE HISTORY:

This burial ground was active from 1945 to 1956. The site contains uranium, plutonium and fission products from the 300 Area fuel fabrication with incidental additional waste from a very small laboratory operation.

REFERENCES:
Documents: HW-43121
Photographs: 122440-267-CN
Drawings: H-3-57210, H-3-32585

9413218.0786

Ref. 8.9

SITE ID NO.: 618-1

CHEMICALS DISPOSED

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
MN-54:	0.00000	PM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.00000	NP-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.06000
ZR-95:	0.00000	PU-240:	0.01700
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00000
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.00000
CS-137:	0.00000	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

These values are decayed through April 1, 1986.

Ref. 8.10

ALIAS: Solid Waste Burial Ground #2
STATUS: Inactive
DIMENSIONS:
Length: 350 ft
Width: 215 ft
Depth: 15 ft
Diameter: 0 ft

FACILITY: Burial Ground
ELEVATION: 385 ft
WATERTABLE: 43 ft

LOCATION: 600 Area
COORDINATES: N55700/WE15060, N55700/E14845, N56050/E14845, N56050/E15060

SITE DESCRIPTION:

Burial ground containing four trenches running east-west. One trench is 51 ft. wide (top width) x 150 ft. long x 15 ft. deep, with a bottom width of 6 ft. The location and dimensions of three trenches are unknown.

SERVICE DATES: 1951-1954

SERVICE HISTORY:

This burial ground was active from 1951 - 1954. The burial ground was used for disposal of uranium-contaminated equipment and materials, plutonium, and fission products. The uranium waste was typically solid metallic uranium oxides in the form of metal cuttings from reactor fuel fabrication facilities in the 300 Area.

REFERENCES:
Documents:
Photographs: 122440-281-CN
Drawings: H-3-57210, H-3-32585

SITE ID NO.: 618-2

CHEMICALS DISPOSED

No chemical inventory is available.

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
MN-54:	0.00000	PM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.00000	NP-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.00000
ZR-95:	0.00000	PU-240:	0.00000
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00000
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	2000.00000
CS-137:	0.00000	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

These values are decayed through April 1, 1986.

Ref. 8.12

SITE ID NO.: 618-3

ALIAS: Burial Ground #3
STATUS: Inactive
DIMENSIONS:
Length: 350 ft
Width: 165 ft
Depth: 15 ft
Diameter: 0 ft

FACILITY: Burial Ground
ELEVATION: 385 ft
WATERTABLE: 43 ft

LOCATION: 600 Area
COORDINATES: N55703/E14677, N55703/E14832, N56045/E14677, N56045/E14832

SITE DESCRIPTION:

Burial ground consisting of one large trench running north-south, 350 ft. x 165 ft. x 15 ft. deep.

SERVICE DATES: 1954-1955

SERVICE HISTORY:

This burial ground was active from 1954 - 1955. The site was primarily used for the disposal of uranium waste in the form of contaminated building material derived from the 313 buildings.

REFERENCES:
Documents:
Photographs: 122440-282-CN
Drawings: H-3-57210, H-3-32585

Ref. 8.13

SITE ID NO.: 618-3

CHEMICALS DISPOSED

No chemical inventory is available.

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
MN-54:	0.00000	PM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.00000	NP-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.00000
ZR-95:	0.00000	PU-240:	0.00000
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00000
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.00000
CS-137:	0.00000	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

Although used for radioactive waste disposal, no inventory is available.

These values are decayed through April 1, 1986.

Ref. 8.14

SITE ID NO.: 618-4

ALIAS: Burial Ground #4
STATUS: Inactive
DIMENSIONS:
Length: 570 ft
Width: 220 ft
Depth: 15 ft
Diameter: 0 ft

FACILITY: Burial Ground
ELEVATION: 400 ft
WATERTABLE: 58 ft

LOCATION: 600 Area
COORDINATES: N57832/E14546 (Southwest Corner)

SITE DESCRIPTION:

Burial ground containing elongated pits which were filled and covered with clean dirt.

SERVICE DATES: 1955-1961

SERVICE HISTORY:

This burial ground was active from 1955 - 1961. The site contains an unknown quantity of uranium-contaminated miscellaneous materials.

REFERENCES:
Documents:
Photographs: 122440-262-CN
Drawings: H-3-57210, H-3-32585

SITE ID NO.: 618-4

CHEMICALS DISPOSED

No chemical inventory is available.

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
MN-54:	0.00000	PM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.00000	NP-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.00000
ZR-95:	0.00000	PU-240:	0.00000
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00000
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.00000
CS-137:	0.00000	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

Although used for radioactive waste disposal, no inventory is available.

These values are decayed through April 1, 1986.

Ref. 6.16

ALIAS: Burial Ground #5
STATUS: Inactive
DIMENSIONS:
Length: 300 ft
Width: 18 ft
Depth: 15 ft
Diameter: 0 ft

FACILITY: Burial Ground
ELEVATION: 374 ft
WATERTABLE: 32 ft

LOCATION: 600 Area
COORDINATES: N57245/E15429 (Southwest corner)

SITE DESCRIPTION:

Burial ground containing a burning trench oriented northeast-southwest by its largest dimension. It was covered and filled with 4 ft. of clean soil.

SERVICE DATES: 1945-1962

SERVICE HISTORY:

This burial ground was active from the mid 1945 to 1962. The site was used as a burning pit for uranium-bearing trash and for non-radioactive trash collected from the 300 Area.

REFERENCES:
Documents:
Photographs: 122440-265-CN, 122440-277-CN, 122440-266-CN
Drawings: H-3-57210, H-3-32585

Ref. 8.17

9413215.0795

SITE ID NO.: 618-5

CHEMICALS DISPOSED

No chemical inventory is available.

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
MN-54:	0.00000	PM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.00000	NP-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.00000
ZR-95:	0.00000	PU-240:	0.00000
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00000
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.00000
CS-137:	0.00000	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

Although used for radioactive waste disposal, no inventory is available.

These values are decayed through April 1, 1986.

SITE ID NO.: 618-7

ALIAS: Burial Ground #7
STATUS: Inactive
DIMENSIONS:
Length: 1120 f
Width: 650 ft
Depth: 12 ft
Diameter: 0 ft

FACILITY: Burial Ground
ELEVATION: 396 ft
WATERTABLE: 54 ft

LOCATION: 600 Area
COORDINATES: N56300/E12655, N56300/E11995, N57420/E12655, N57420/E11995

SITE DESCRIPTION:

There are two drive-in, east-west oriented trenches. Both trenches have been closed and backfilled. The V-shaped pit in the center (approximately N56550) was used for thoria disposal. The site was backfilled and covered with clean soil.

SERVICE DATES: 1960-1973

SERVICE HISTORY:

Materials primarily from the 300 area fuel element manufacturing process. They are slightly contaminated with uranium or thorium, and some beryllium contaminated zircalloy is also in these pits.

REFERENCES:
Documents: HW-77274
Photographs: 122440-273-CN
Drawings: H-3-57210, M-6000 #1, H-3-32585

Ref. 8.19

SITE ID NO.: 618-7

CHEMICALS DISPOSED

No chemical inventory is available.

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
MN-54:	0.00000	PM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.00000	NP-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.00000
ZR-95:	0.00000	PU-240:	0.00000
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U=238:	0.00000
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.00000
CS-137:	0.00000	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

Although used for radioactive waste disposal, no inventory is available.

These values are decayed through April 1, 1986.

Ref. 8.20

SITE ID NO.: 618-9

ALIAS: 300 West Burial Ground
STATUS: Inactive
DIMENSIONS:
Length: 200 ft
Width: 18 ft
Depth: 8 ft
Diameter: 0 ft

FACILITY: Burial Ground
ELEVATION: 400 ft
WATERTABLE: 58 ft

LOCATION: 600 Area
COORDINATES: N55738/E11016, N55738/E10998, N55938/E11016, N55938/E10998

SITE DESCRIPTION:

Burial ground consisting of a trench 18-20 ft. wide x 140 ft. long (surface dimensions) x 8 ft. deep.

SERVICE DATES: 1950-1956

SERVICE HISTORY:

This burial ground was active from 1950 - 1956. The site contains 55-gallon drums of uranium contaminated organic solvent (5000 gal) from the 321 building. It was removed from service, backfilled, identified with markers, and stabilized.

REFERENCES:
Documents:
Photographs: 122440-271-CN
Drawings: H-3-57210, H-3-32585

Ref. 8.21

SITE ID NO.: 618-9

CHEMICALS DISPOSED

TRIBUTYL PHOSPHATE:	6000 kg
PARAFFIN HYDROCARBON:	10000 kg

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
MN-54:	0.00000	PM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.00000	NP-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.00000
ZR-95:	0.00000	PU-240:	0.00000
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00000
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.00000
CS-137:	0.00000	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

Although used for radioactive waste disposal, no inventory is available.

These values are decayed through April 1, 1986.

Ref. 8.22

ALIAS: North Process Pond Scraping Disposal Area
STATUS: Inactive
DIMENSIONS:
    Length: 400 ft
    Width: 200 ft
    Depth: 8 ft
    Diameter: 0 ft

FACILITY: Burial Ground
ELEVATION: 376 ft
WATERTABLE: 34 ft

LOCATION: 600 Area
COORDINATES: N56300/E15350, N56625/E15275, N57000/E15275, N56800/E15350

SITE DESCRIPTION:

The North Process Pond Scraping Disposal Area extends about 200 ft. south from the North Process Ponds.

SERVICE DATES: 1949-1964

SERVICE HISTORY:

This site was used for disposal of uranium contaminated soil scraped from 316-2 (North Process Pond) and some uranium contaminated soil removed from beneath the 321 Building during excavation for hydraulic core mockup. The site has been backfilled with ashes.

REFERENCES:
    Documents:
    Photographs: 54217-2
    Drawings: H-3-57210

SITE ID NO.: 618-12

CHEMICALS DISPOSED

No chemical inventory is available.

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
MN-54:	0.00000	PM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.00000	NP-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.00000
ZR-95:	0.00000	PU-240:	0.00000
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00000
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.00000
CS-137:	0.00000	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

Although used for radioactive waste disposal, no inventory is available.

These values are decayed through April 1, 1986.

Ref. 8.24

SITE ID NO.: 618-13

ALIAS: 303 Area Contaminated Soil Burial Site, 318-13
STATUS: Inactive
DIMENSIONS:
Length: 125 ft
Width: 50 ft
Depth: 0 ft
Diameter: 0 ft

FACILITY: Burial Ground
ELEVATION: 400 ft
WATERTABLE: 58 ft

LOCATION: 600 Area
COORDINATES: N55575/E11400 (Center of site)

SITE DESCRIPTION:

A mound of soil piled to approximately 50 ft. high x 125 ft. long x 50 ft. wide covered with 2 ft. of clean soil.

SERVICE DATES: 1950-1950

SERVICE HISTORY:

Top soil from the 303 area removed in 1950 was piled approximately one-half to three-quarters of a mile northwest of the 300 area, and covered with two feet of clean soil. Total activity buried here is not known. The mound of covered contaminated material has been posted as a radiation zone.

REFERENCES:
Documents: HW-39076
Photographs: 122440-272-CN, 29033
Drawings: H-3-57210, H-3-32585

SITE ID NO.: 618-13

CHEMICALS DISPOSED

No chemical inventory is available.

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
MN-54:	0.00000	PM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.00000	NP-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.00000
ZR-95:	0.00000	PU-240:	0.00000
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00000
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.00000
CS-137:	0.00000	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

Although used for radioactive waste disposal, no inventory is available.

These values are decayed through April 1, 1986.

Ref. 8.26

SITE ID NO.: Horn Rapids Disposal

ALIAS: Horn Rapids Landfill, ITT Waste Disposal Landfill
STATUS: Inactive
DIMENSIONS:
- Length: 1000 f
- Width: 800 ft
- Depth: 40 ft
- Diameter: 0 ft

FACILITY: Landfill
ELEVATION: 450 ft
WATERTABLE: 50 ft

LOCATION: 600 Area
COORDINATES: To be determined

SITE DESCRIPTION:

The site is approximately 1000 ft. x 800 ft. with varying depths averaging about 40 ft. The site is surrounded by a 12 ft. chain link fence, kept locked and posted. It is now a designated curlew nesting area and access is prohibited.

SERVICE DATES: 1950-1970

SERVICE HISTORY:

This site was used primarily for wastes generated in the 1100 Area. It contains paper, office, and minor construction wastes (paint cans, solvents, and oils.) It has not been used since 1970.

REFERENCES:
- Documents:
- Photographs: 122440-283-CN
- Drawings: H-3-57210, M-6000 #1

Ref. 8.27

SITE ID NO.: Horn Rapids Disposal

CHEMICALS DISPOSED

No chemical inventory is available.

RADIONUCLIDE INVENTORY
(in curies)

H-3:	0.00000	CE-144:	0.00000
C-14:	0.00000	PR-144:	0.00000
MN-54:	0.00000	PM-147:	0.00000
CO-60:	0.00000	EU-152:	0.00000
NI-63:	0.00000	EU-154:	0.00000
KR-85:	0.00000	EU-155:	0.00000
SR-90:	0.00000	NP-237:	0.00000
Y-91:	0.00000	PU-238:	0.00000
NB-95:	0.00000	PU-239:	0.00000
ZR-95:	0.00000	PU-240:	0.00000
TC-99:	0.00000	PU-241:	0.00000
RU-103:	0.00000	AM-241:	0.00000
RU-106:	0.00000	U-233:	0.00000
SN-113:	0.00000	U-235:	0.00000
SB-125:	0.00000	U-238:	0.00000
I-129:	0.00000	TH-232:	0.00000
CS-134:	0.00000	BETA:	0.00000
CS-137:	0.00000	GAMMA:	0.00000
CE-141:	0.00000	ALPHA:	0.00000

This site was not used to deliberately dispose of radioactive waste.

These values are decayed through April 1, 1986.

Ref. 8.28

REFERENCE 9

<u>Uncontrolled Hazardous Waste Site Ranking System;</u>

<u>A Users Manual</u>, 40 CFR 300, Appendix A

Physical state refers to the state of the hazardous substances at the time of disposal, except that gases generated by the hazardous substances in a disposal area should be considered in rating this factor. Each of the hazardous substances being evaluated is assigned a value as follows:

Physical state	Assigned value
Solid, consolidated or stabilized	0
Solid, unconsolidated or unstabilized	1
Powder or fine material	2
Liquid, sludge or gas	3

3.3 Containment

Containment is a measure of the natural or artificial means that have been used to minimize or prevent a contaminant from entering ground water. Examples include liners, leachate collection systems, and sealed containers. In assigning a value to this rating factor (Table 3), consider all ways in which hazardous substances are stored or disposed at the facility. If the facility involves more than one method of storage or disposal, assign the highest from among all applicable values (e.g., if a landfill has a containment value of 1, and, at the same location, a surface impoundment has a value of 3, assign containment a value of 3).

TABLE 3—CONTAINMENT VALUE FOR GROUND WATER ROUTE

Assign containment a value of 0 if: (1) All the hazardous substances at the facility are underlain by an essentially non permeable surface (natural or artificial) and adequate leachate collection systems and diversion systems are present; or (2) there is no ground water in the vicinity. The value "0" does not indicate no risk. Rather, it indicates a significantly lower relative risk when compared with more serious sites on a national level. Otherwise, evaluate the containment for each of the different means of storage or disposal at the facility, using the following guidance.

	Assigned value
A. Surface Impoundment	
Sound run-on diversion structure, essentially non permeable liner (natural or artificial) compatible with the waste, and adequate leachate collection system	0
Essentially non permeable compatible liner with no leachate collection system; or inadequate freeboard	1
Potentially unsound run-on diversion structure, or moderately permeable compatible liner	2
Unsound run-on diversion structure, no liner, or incompatible liner	3
B. Containers	
Containers sealed and in sound condition, adequate liner, and adequate leachate collection system	0

TABLE 3—CONTAINMENT VALUE FOR GROUND WATER ROUTE—Continued

Assign containment a value of 0 if: (1) All the hazardous substances at the facility are underlain by an essentially non permeable surface (natural or artificial) and adequate leachate collection systems and diversion systems are present; or (2) there is no ground water in the vicinity. The value "0" does not indicate no risk. Rather, it indicates a significantly lower relative risk when compared with more serious sites on a national level. Otherwise, evaluate the containment for each of the different means of storage or disposal at the facility, using the following guidance.

	Assigned value
Containers sealed and in sound condition, no liner or moderately permeable liner	1
Containers leaking, moderately permeable liner	2
Containers leaking and no liner or incompatible liner	3
C. Piles	
Piles uncovered and waste stabilized; or piles covered, waste unstabilized, and essentially non permeable liner	0
Piles uncovered, waste unstabilized, moderately permeable liner, and leachate collection system	1
Piles uncovered, waste unstabilized, moderately permeable liner, and no leachate collection system	2
Piles uncovered, waste unstabilized, and no liner	3
D. Landfill	
Essentially non permeable liner, liner compatible with waste, and adequate leachate collection system	0
Essentially non permeable compatible liner, no leachate collection system, and landfill surface precludes ponding	1
Moderately permeable, compatible liner, and landfill surface precludes ponding	2
No liner or incompatible liner; moderately permeable compatible liner; landfill surface encourages ponding; no run-on control	3

3.4 *Waste Characteristics.* In determining a waste characteristics score, evaluate the most hazardous substances at the facility that could migrate (i.e., if scored, containment is not equal to zero) to ground water. Take the substance with the highest score as representative of the potential hazard due to waste characteristics. Note that the substance that may have been observed in the release category can differ from the substance used in rating waste characteristics. Where the total inventory of substances in a facility is known, only those present in amounts greater than the reportable quantity (see CERCLA section 102 for definition) may be evaluated.

Toxicity and *Persistence* have been combined in the matrix below because of their important relationship. To determine the overall value for this combined factor, evaluate each factor individually as discussed below. Match the individual values assigned with the values in the matrix for the combined rating factor. Evaluate several of the most hazardous substances at the facility independently and enter only the highest score in the matrix on the work sheet.

Value for toxicity	Value for persistence: 0	1	2	3
0	0	0	0	0
1	3	6	9	12
2	6	9	12	15
3	9	12	15	18

Persistence of each hazardous substance is evaluated on its biodegradability as follows:

Substance	Assigned value
Easily biodegradable compounds	0
Straight chain hydrocarbons	1
Substituted and other ring compounds	2
Metals, polycyclic compounds and halogenated hydrocarbons	3

More specific information is given in Tables 4 and 5.

TABLE 4—WASTE CHARACTERISTICS VALUES FOR SOME COMMON CHEMICALS

Chemical/Compound	Toxicity[1]	Persistence[2]	Ignitability[3]	Reactivity[3]
Acetaldehyde	3	0	3	2
Acetic Acid	3	0	2	1
Acetone	2	0	3	0
Aldrin	3	3	1	0
Ammonia, Anhydrous	3	0	1	0
Aniline	3	1	2	0
Benzene	3	1	3	0
Carbon Tetrachloride	3	3	0	0
Chlordane	3	3	*0	*0
Chlorobenzene	2	2	3	0
Chloroform	3	3	0	0
Cresol-O	3	1	2	0
Cresol-M&P	3	1	1	0
Cyclohexane	2	2	3	0
Endrin	3	3	1	0
Ethyl Benzene	2	1	3	0
Formaldehyde	3	0	2	0
Formic Acid	3	0	2	0
Hydrochloric Acid	3	0	0	0
Isopropyl Ether	3	1	3	1
Lindane	3	3	1	0
Methane	1	1	3	0
Methyl Ethyl Ketone	2	0	3	0
Methyl Parathion in Xylene Solution	3	[4]3	3	2
Naphthalene	2	1	2	0
Nitric Acid	3	0	0	0
Parathion	3	[4]3	1	2
PCB	3	3	[4]3	[4]3
Petroleum, Kerosene (Fuel Oil No. 1)	3	1	2	0
Phenol	3	1	2	0

TABLE 4—WASTE CHARACTERISTICS VALUES FOR SOME COMMON CHEMICALS—Continued

Chemical/Compound	Toxicity[1]	Persistence[2]	Ignitability[3]	Reactivity[3]
Sulfuric Acid	3	0	0	2
Toluene	2	1	3	0
Trichlorobenzene	2	3	1	0
1,1,1-Trichloroethane	2	2	1	0
Xylene	2	1	3	0

[1] Sax, N. I., *Dangerous Properties of Industrial Materials*, Van Nostrand Reinhold Co., New York, 4th ed., 1975. The highest rating listed under each chemical is used.
[2] JRB Associates, Inc., *Methodology for Rating the Hazard Potential of Waste Disposal Sites*, May 5, 1980.
[3] National Fire Protection Association, National Fire Codes, Vol. 13, No. 49, 1977.
[4] Professional judgment based on information contained in the U.S. Coast Guard CHRIS *Hazardous Chemical Data*, 1978.
[5] Professional judgment based on existing literature.

TABLE 5—PERSISTENCE (BIODEGRADABILITY) OF SOME ORGANIC COMPOUNDS*

Value = 3 Highly Persistent Compounds	
aldrin	heptachlor
benzopyrene	heptachlor epoxide
benzothiazole	1,2,3,4,5,7,7-heptachloronorbornene
benzothiophene	hexachlorobenzene
benzyl butyl phthalate	hexachloro-1,3-butadiene
bromochlorobenzene	hexachlorocyclohexane
bromoform butanal	hexachloroethane
bromophenyl phenyl ether	methyl benzothiazole
chlordane	pentachlorobiphenyl
chlorohydroxy benzophenone	pentachlorophenol
bis-chloroisopropyl ether	1,1,3,3-tetrachloroacetone
m-chloronitrobenzene	tetrachlorophenyl
DDE	thiomethylbenzothiazole
DDT	trichlorobenzene
dibromobenzene	trichlorobiphenyl
dibutyl phthalate	trichlorofluoromethane
1,4-dichlorobenzene	2,4,6-trichlorophenol
dichlorodifluoroethane	triphenyl phosphate
dieldrin	bromodichloromethane
diethyl phthalate	bromoform
di(2-ethylhexyl)phthalate	carbon tetrachloride
dihexyl phthalate	chloroform
di-isobutyl phthalate	chloromochloromethane
dimethyl phthalate	dibromodichloroethane
4,6-dinitro-2-aminophenol	tetrachloroethane
dipropyl phthalate	1,1,2-trichloroethane
endrin	
Value = 2 Persistent Compounds	
acenaphthylene	cis-2-ethyl-4-methyl-1,3-dioxolane
atrazine	trans-2-ethyl-4-methyl-1,3-dioxolane
(diethyl) atrazine	guaiacol
barbital	2-hydroxyadiponitrile
borneol	isophorone
bromobenzene	indene
camphor	isoborneol
chlorobenzene	isopropenyl-4-isopropyl benzene
1,2-bis-chloroethoxy ethane	2-methoxy biphenyl
b-chloroethyl methyl ether	methyl biphenyl
chloromethyl ether	methyl chloride

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TABLE 5—PERSISTENCE (BIODEGRADABILITY) OF SOME ORGANIC COMPOUNDS*—Continued

chloromethyl ethyl ether	methylindene
2-chloropyridine	methylene chloride
di-t-butyl-p-benzoquinone	nitroanisole
dichloroethyl ether	nitrobenzene
dihydrocarvone	1,1,2-trichloroethylene
dimethyl sulfoxide	trimethyl-trans-[illegible] isomer
2,6-dinitrotoluene	
Value=1 Somewhat Persistent Compounds	
acetylene dichloride	limonene
behenic acid, methyl ester	methyl ester of lignoceric acid
benzene	methane
benzene sulfonic acid	2-methyl-5-ethyl-pyridine
butyl benzene	methyl naphthalene
butyl bromide	methyl palmitate
e-caprolactam	methyl phenyl carbinol
carbon-disulfide	methyl stearate
o-cresol	naphthalene
decane	nonane
1,2-dichloroethane	octane
1,2-dimethoxy benzene	octyl chloride
1,3-dimethyl naphthalene	pentane
1,4-dimethyl phenol	phenyl benzoate
dioctyl adipate	phthalic anhydride
n-decane	propylbenzene
ethyl benzene	1-terpineol
2-ethyl-n-hexane	toluene
o-ethyltoluene	vinyl benzene
isodecane	xylene
isopropyl benzene	
Value=0 Nonpersistent Compounds	
acetaldehyde	methyl benzoate
acetic acid	3-methyl butanol
acetone	methyl ethyl ketone
acetophenone	2-methylpropanol
benzoic acid	octadecane
di-isobutyl carbinol	pentadecane
docosane	pentanol
eicosane	propanol
ethanol	propylamine
ethylamine	tetradecane
hexadecane	n-tridecane
methanol	n-undecane

* JRB Associates, Inc., *Methodology for Rating the Hazard Potential for Waste Disposal Sites*, May 5, 1980.

Toxicity of each hazardous substance being evaluated is given a value using the rating scheme of Sax (Table 6) or the National Fire Protection Association (NFPA) (Table 7) and the following guidance:

Toxicity	Assigned value
Sax level 0 or NFPA level 0	0
Sax level 1 or NFPA level 1	1
Sax level 2 or NFPA level 2	2
Sax level 3 or NFPA level 3 or 4	3

TABLE 6—SAX TOXICITY RATINGS

0—No Toxicity* (None)**

This designation is given to materials which fall into one of the following categories:
(a) Materials which cause no harm under any conditions of normal use.
(b) Materials which produce toxic effects on humans only under the most unusual conditions or by overwhelming dosage.

1—Slight Toxicity* (Low)**

(a) *Acute local.* Materials which on single exposures lasting seconds, minutes, or hours cause only slight effects on the skin or mucous membranes regardless of the extent of the exposure.
(b) *Acute systemic.* Materials which can be absorbed into the body by inhalation, ingestion, or through the skin and which produce only slight effects following single exposures lasting seconds, minutes, or hours, or following ingestion of a single dose, regardless of the quantity absorbed or the extent of exposure.
(c) *Chronic local.* Materials which on continuous or repeated exposures extending over periods of days, months, or years cause only slight and usually reversible harm to the skin or mucous membranes. The extent of exposure may be great or small.
(d) *Chronic systemic.* Materials which can be absorbed into the body by inhalation, ingestion, or through the skin and which produce only slight usually reversible effects extending over days, months, or years. The extent of the exposure may be great or small.
In general, those substances classified as having "slight toxicity" produce changes in the human body which are readily reversible and which will disappear following termination of exposure, either with or without medical treatment.

2—Moderate Toxicity* (Mod)**

(a) *Acute local.* Materials which on single exposure lasting seconds, minutes, or hours cause moderate effects on the skin or mucous membranes. These effects may be the result of intense exposure for a matter of seconds or moderate exposure for a matter of hours.
(b) *Acute systemic.* Materials which can be absorbed into the body by inhalation, ingestion, or through the skin and produce moderate effects following single exposures lasting seconds, minutes, or hours, or following ingestion of a single dose.

TABLE 6—SAX TOXICITY RATINGS—Continued

2—Moderate Toxicity* (Mod)**

(c) *Chronic local.* Materials which on continuous or repeated exposures extending over periods of days, months, or years cause moderate harm to the skin or mucous membranes.
(d) *Chronic systemic.* Materials which can be absorbed into the body by inhalation, ingestion, or through the skin and which produce moderate effects following continuous or repeated exposures extending over periods of days, months, or years.
Those substances classified as having "moderate toxicity" may produce irreversible as well as reversible changes in the human body. These changes are not of such severity as to threaten life or to produce serious physical impairment.

3—Severe Toxicity* (High)**

(a) *Acute local.* Materials which on single exposure lasting seconds or minutes cause injury to skin or mucous membranes of sufficient severity to threaten life or to cause permanent physical impairment or disfigurement.
(b) *Acute systemic.* Materials which can be absorbed into the body by inhalation, ingestion, or through the skin and which can cause injury of sufficient severity to threaten life following a single exposure lasting seconds, minutes, or hours, or following ingestion of a single dose.
(c) *Chronic local.* Materials which on continuous or repeated exposures extending over periods of days, months, or years can cause injury to skin or mucous membranes of sufficient severity to threaten life or cause permanent impairment, disfigurement, or irreversible change.
(d) *Chronic systemic.* Materials which can be absorbed into the body by inhalation, ingestion or through the skin and which can cause death or serious physical impairment following continuous or repeated exposures to small amounts extending over periods of days, months, or years.

* Sax, N. I., Dangerous Properties of Industrial Materials, Van Nostrand Reinhold Co., New York, New York, 4th edition, 1975.
** Sax, N. I., Dangerous Properties of Industrial Materials, Van Nostrand Reinhold Co., New York, New York, 5th edition, 1979.

TABLE 7—NFPA TOXICITY RATINGS*

0 Materials which on exposure under fire conditions would offer no health hazard beyond that of ordinary combustible material.
1 Materials only slightly hazardous to health. It may be desirable to wear self-contained breathing apparatus.
2 Materials hazardous to health, but areas may be entered freely with self-contained breathing apparatus.
3 Materials extremely hazardous to health, but areas may be entered with extreme care. Full protective clothing, including self-contained breathing apparatus, rubber gloves, boots and bands around legs, arms and waist should be provided. No skin surface should be exposed.
4 A few whiffs of the gas or vapor could cause death, or the gas, vapor, or liquid could be fatal on penetrating the fire fighters' normal full protective clothing which is designed for resistance to heat. For most chemicals having a Health 4 rating, the normal full protective clothing available to the average fire department will not provide adequate protection against skin contact with these materials. Only special protective clothing designed to protect against the specific hazard should be worn.

* National Fire Protection Association, National Fire Codes, Vol. 13, No. 49, 1977.

Table 4 presents values for some common compounds.

Hazardous waste quantity includes all hazardous substances at a facility (as received) except that with a containment value of 0. Do not include amounts of contaminated soil or water; in such cases, the amount of contaminating hazardous substance may be estimated.

On occasion, it may be necessary to convert data to a common unit to combine them. In such cases, 1 ton=1 cubic yard=4 drums and for the purposes of converting bulk storage, 1 drum=50 gallons. Assign a value as follows:

Tons in cubic yards	Number of drums	Assigned value
0	0	0
1-10	1-40	1
11-62	41-250	2
63-125	251-500	3
126-250	501-1,000	4
251-625	1,001-2,500	5
626-1,250	2,501-5,000	6
1,251-2,500	5,001-10,000	7
>2,500	>10,000	8

3.5 *Targets.* Ground water use indicates the nature of the use made of ground water drawn from the aquifer of concern within 3 miles of the hazardous substance, including the geographical extent of the measurable concentration in the aquifer. Assign a value using the following guidance:

Ground water use	Assigned value
Unusable (e.g., extremely saline aquifer, extremely low yield, etc.)	0
Commercial, industrial or irrigation and another water source presently available, not used, but usable	1
Drinking water with municipal water from alternate unthreatened sources presently available (i.e., minimal hookup requirements); or commercial, industrial or irrigation with no other water source presently available	2
Drinking water; no municipal water from alternate unthreatened sources presently available	3

Distance to nearest well and population served have been combined in the matrix below to better reflect the important relationship between the distance of a population from hazardous substances and the size of the population served by ground water that might be contaminated by those substances. To determine the overall value for this combined factor, score each individual-

Ref. 9.2

REFERENCE 10

Memo to file from KH Cramer on August 6, 1987 regarding Personal Communication with Michael Gillum, City of Richland, concerning Richland Water System (info, maps and data sheets)

MEMO: To File

DATE: 8/6/87

FROM: K. H. Cramer

SUBJECT: Personal conversation with Michael Gillum
Regard Richland City Recharge Wells and Water Supply System

There are 14 recharge wells that are within 3 miles of the Hanford Site boundary. These wells have depths that range from 40 to 134 feet. The recharge well system is part of the city's overall water supply system. The recharge wells are designed to be used in conjunction with the Water Supply holding ponds located beside the wells. The recharge well system is used during peak water demand periods and when the Columbia River Water Pump System is down for maintenance. The recharge system operates with water being pumped to the holding ponds from the Columbia River. The water in the ponds then seeps through the soil to the aquifer where it is pumped by the recharge wells to the city's water supply system. The recharge wells are tied into the overall water supply system, which means that the water from the wells is mixed with the Columbia River water and distributed throughout the city.

509 943-9161

MICHAEL GILLUM

Associate Engineer
Utility Administration Division
Water & Waste Utilities Department

505 SWIFT BOULEVARD BOX 190 RICHLAND WASHINGTON 99352

CITY OF RICHLAND

WATER SYSTEM DATA

A. PRODUCTION

The City of Richland's water supply comes from two major sources:

1. Water Treatment Plant: The Water Treatment Plant uses the "Micro-Floc" process for water treatment (see attached flow diagram). Its present design production capacity is 30 million gallons per day. The plant can be expanded to a maximum production capacity of 45 MGD.
2. Wells: The 18 wells are located in five well fields. The total production capacity of all the wells is 18.2 MGD. The North Richland well field groundwater is recharged artificially through the use of recharge basins (see attachment). The wells are recharged through the months of April to November.

The production capacities can be summarized as follows:

Source	# Wells	Capacity
Columbia Well Field	1	0.8 MGD
Duke Well Field	2	2.0 MGD
North Richland Well Field & D-5	11	11.0 MGD
Wellsian Way Well Field	3	3.0 MGD
Willowbrook Well	1	1.4 MGD
Water Treatment Plant		30.0 MGD
TOTAL	18	48.2 MGD

B. STORAGE

The City of Richland's water system has a water storage capacity of 23.67 million gallons. The major elevated storage, a five and ten million gallon reservoir, is located west of the Yakima River. The other elevated storage consists of five additional reservoirs, with a capacity of 4.47 million gallons and are also located west of the Yakima River, serving the Badger Mountain Area. Water from the remaining reservoirs is pumped into the system by booster pumps.

Storage can be summarized as follows:

Storage		Capacity
Two (2) one-million gallon reservoirs (1182)		2.0 MG
Five million gallon reservoir		5.0 MG
Ten million gallon reservoir		10.0 MG
Water Treatment Plant Clearwell reservoir		2.2 MG
Tapteal I reservoir (reservoir #1)		0.75 MG
Tapteal I reservoir (reservoir #2)		2.6 MG
Tapteal II reservoir (reservoir #1)	Upper Pressure Zone	0.18 MG
Tapteal II reservoir (reservoir #2)	Upper Pressure Zone	0.7 MG
Country Ridge reservoir	Upper Pressure Zone	0.24 MG
TOTAL		23.67 MG

Ref. 10.2

9112128.1086

C. TRANSMISSION

All water transmission lines, 10" or larger, are shown on the utility map of the City of Richland. The major transmission lines are shown on the attached facilities location map.

D. PRESSURE ZONES

The City of Richland has three pressure zones:

1. Richland City core area.
2. Badger Mountain/Meadow Springs area (area west of Yakima River) - Tapteal I pressure zone.
3. Badger Mountain/Meadow Springs area (higher elevations west of Keene Road and portion of Hills West area) - Tapteal II pressure zone.

The Badger Mountain/Meadow Springs area water is pumped from the Richland City core pressure zone to the higher Badger Mountain pressure zone. The booster pump station for this zone is located at the five and ten million gallon reservoirs.

The third pressure zone is supplied by (1) a pumping station off High Meadows Street and currently serves the majority of homes on High Meadows Street, Hillview Drive and all homes west of Orchard Court on Orchard Way and Greenview Drive, and (2) a pumping station on Keene Road at Country Ridge and serves the Country Ridge/ Keene Village area.

Attachment

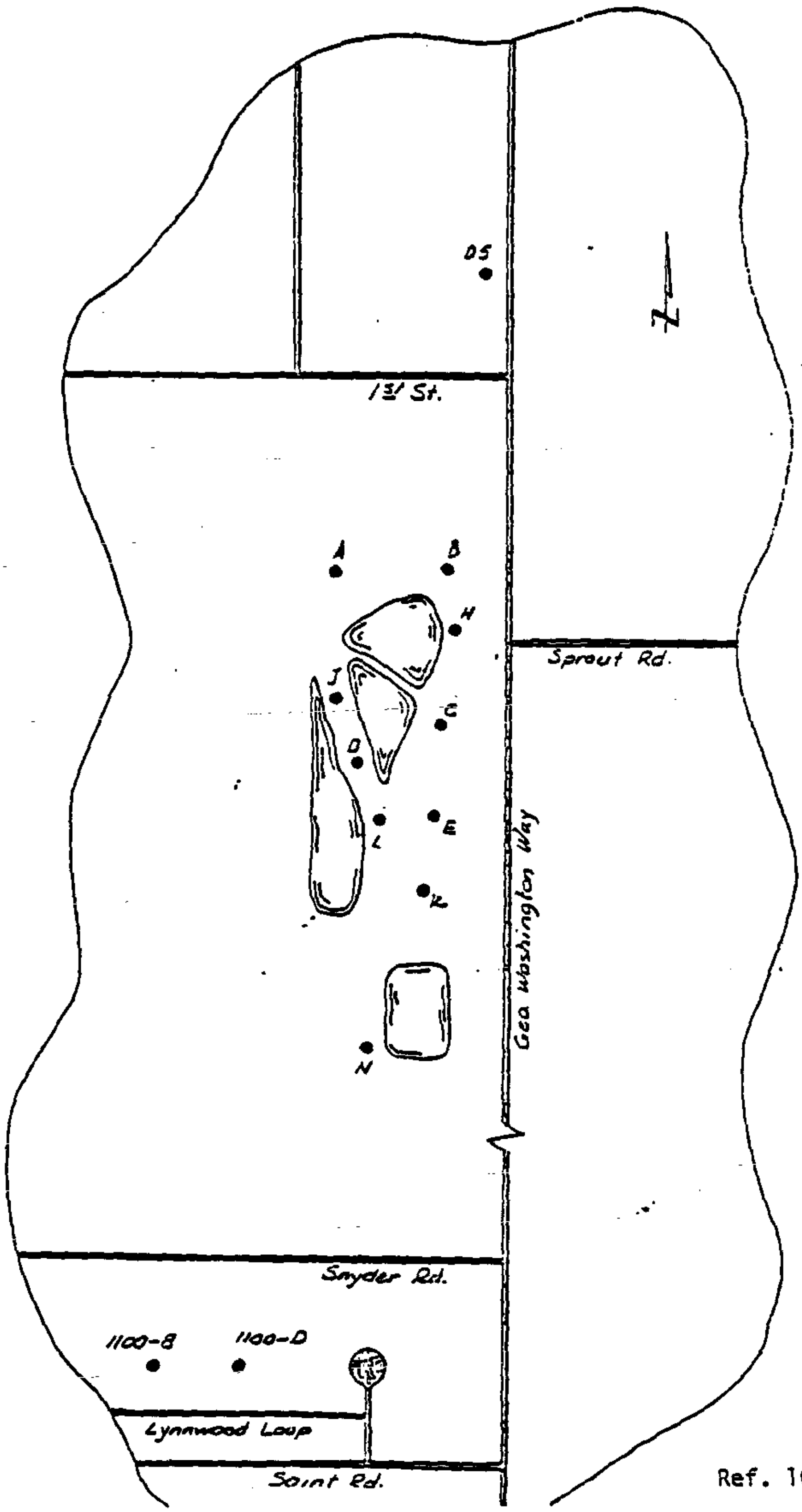
NORTH RICHLAND WELLS

North Richland Well Field

Well #	Depth
3000-A	88'
3000-B	87'
3000-C	64'
3000-D	75.3'
3000-E	61.8'
3000-H	56'
3000-J	71'
3000-K	59'
3000-L	83'
3000-N	40'
3000-05	134'

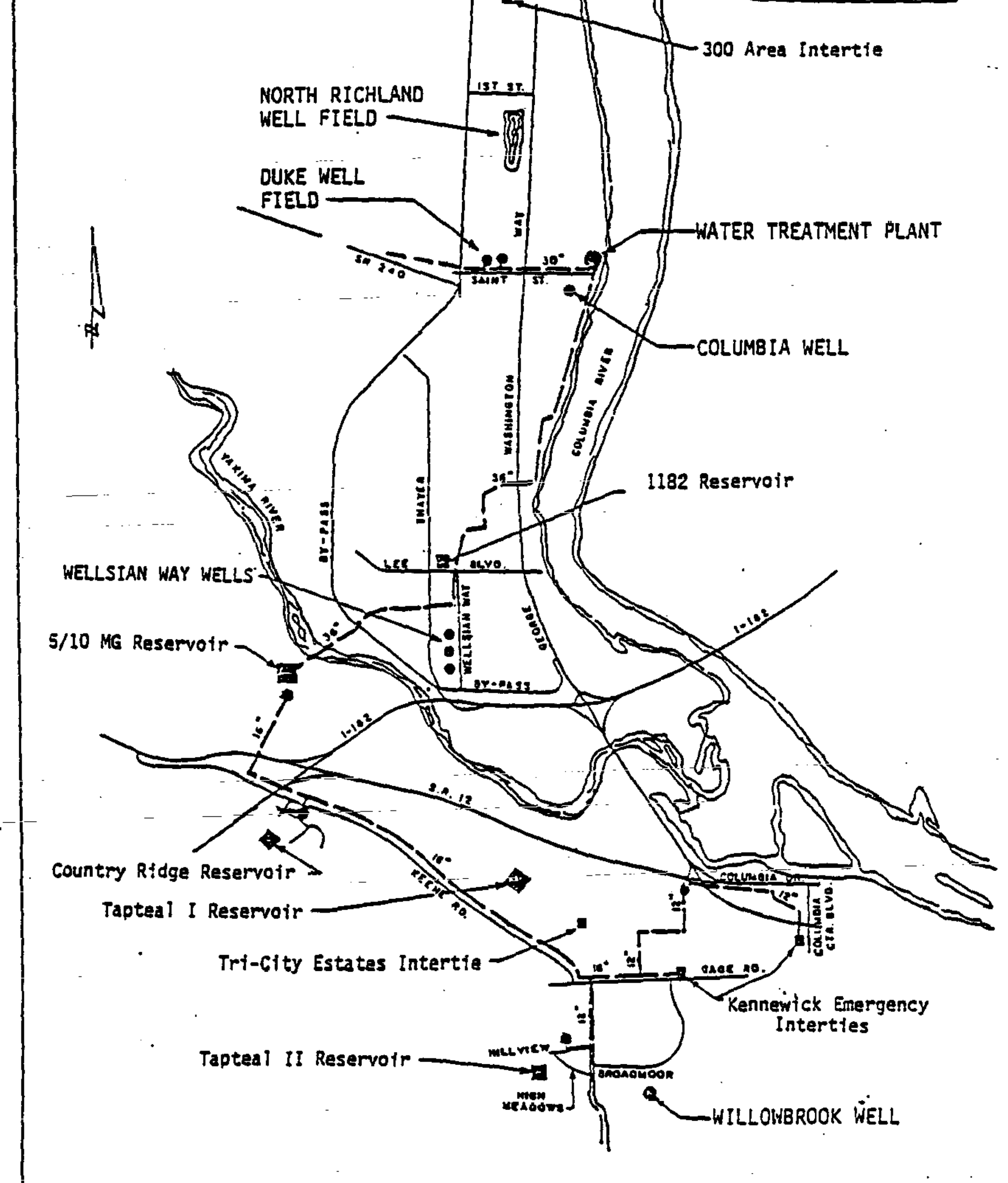
Duke Well Field

Well #	Depth
1100-B	120'
1100-D	86'



Ref. 10.4

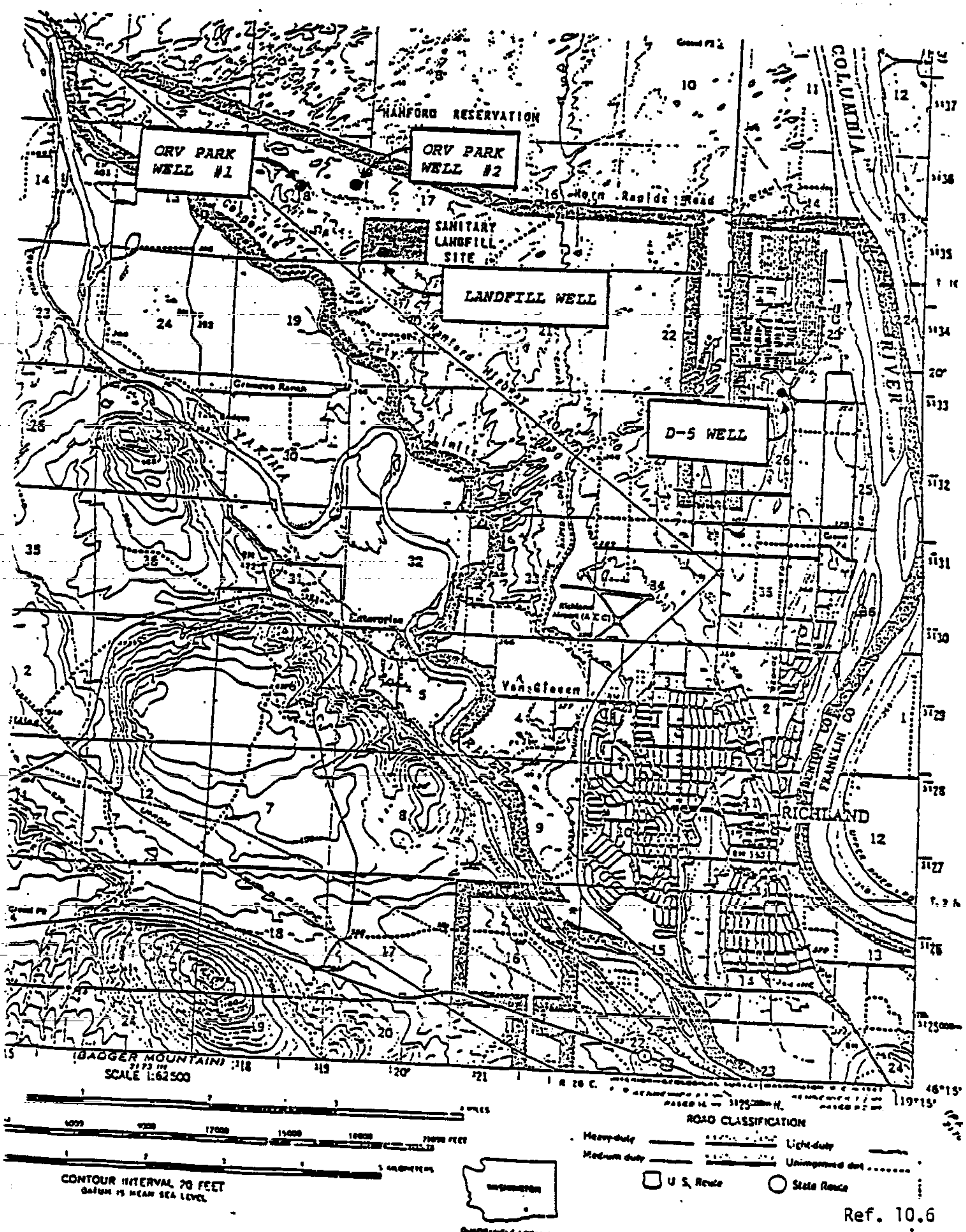
FIGURE III - 4



CITY OF RICHLAND

WATER SYSTEM SOURCE and STORAGE FACILITIES
LOCATION MAP

Ref. 10.5

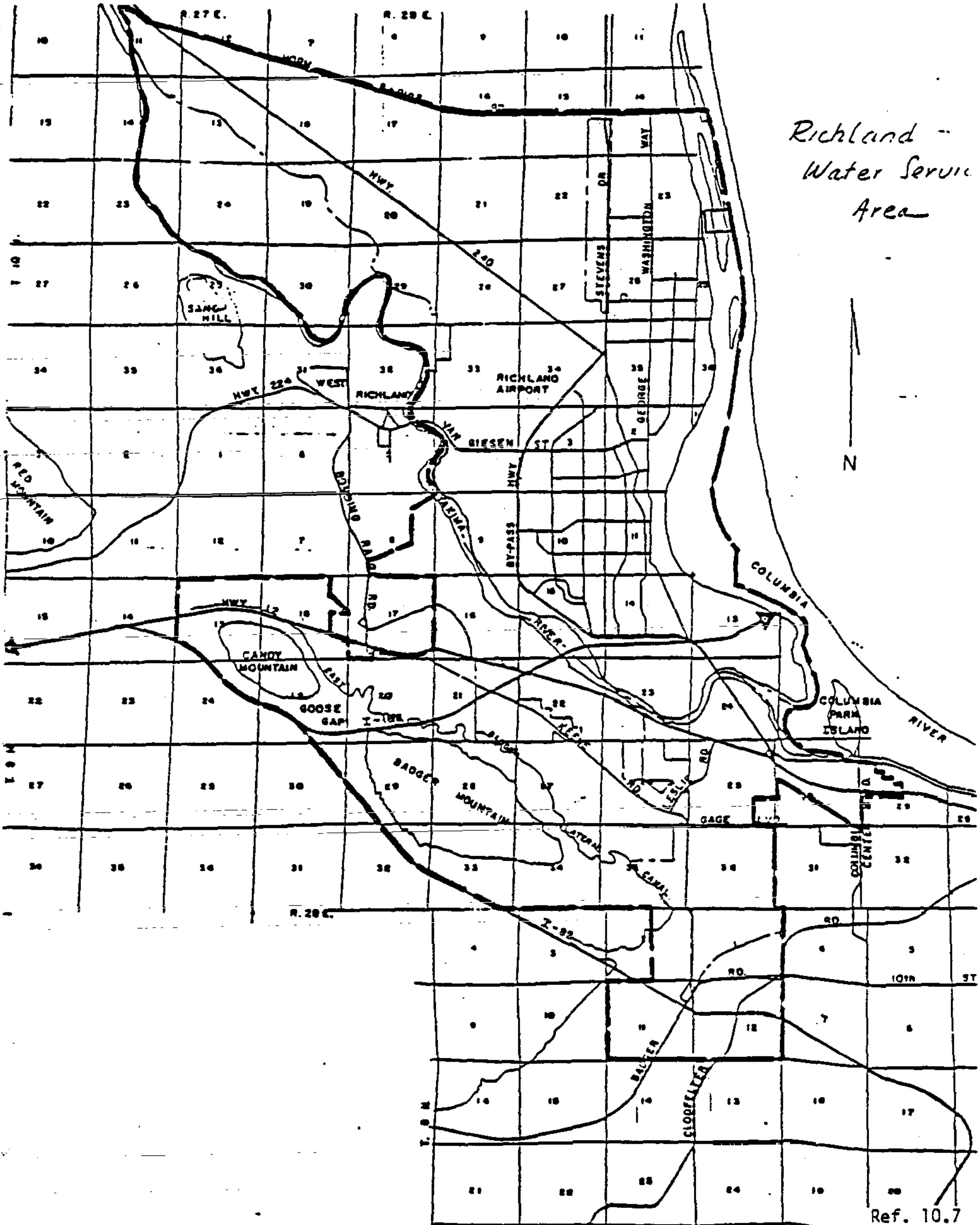


9113278.0815

Ref. 10.6

RICHLAND. WASH

Richland - Water Servic Area



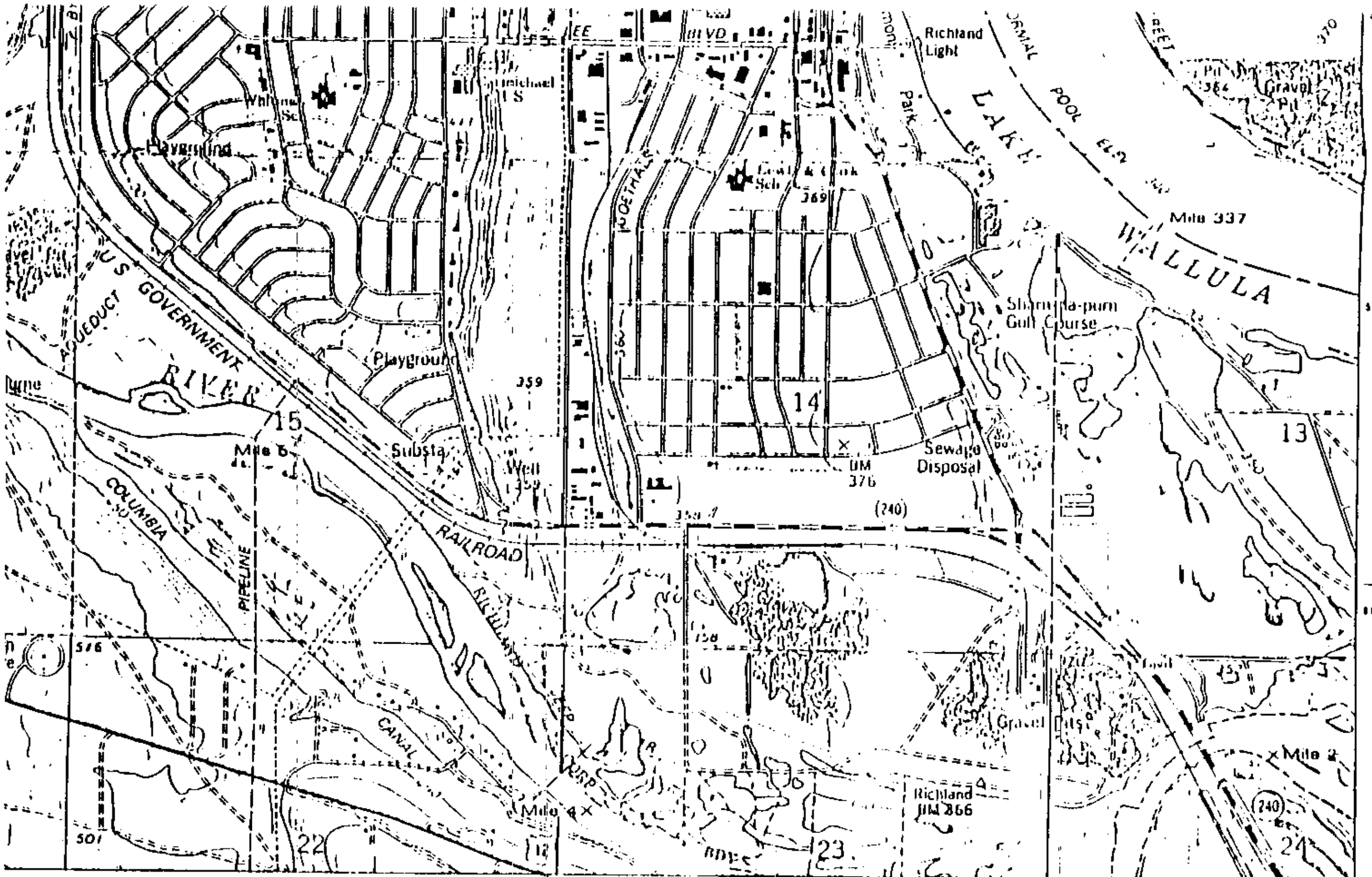
Ref. 10.7

REFERENCE 11

U.S.G.S. Maps showing the 300 Area Surroundings

Richland, Wash 7.5 Minute Map
Mathews Corner, Wash 7.5 Minute Map
Wooded Island, Wash 7.5 Minute Map
Columbia Point, Wash 7.5 Minute Map

1
36123



(KENNEWICK)
2176 II NW

ROAD CLASSIFICATION

Primary highway, hard surface		Light-duty road, hard or improved surface	
Secondary highway, hard surface		Unimproved road	

Interstate Route U. S. Route State Route

1 MILE
5000 6000 7000 FEET
1 KILOMETER

EET
JM OF 1929

QUADRANGLE LOCATION

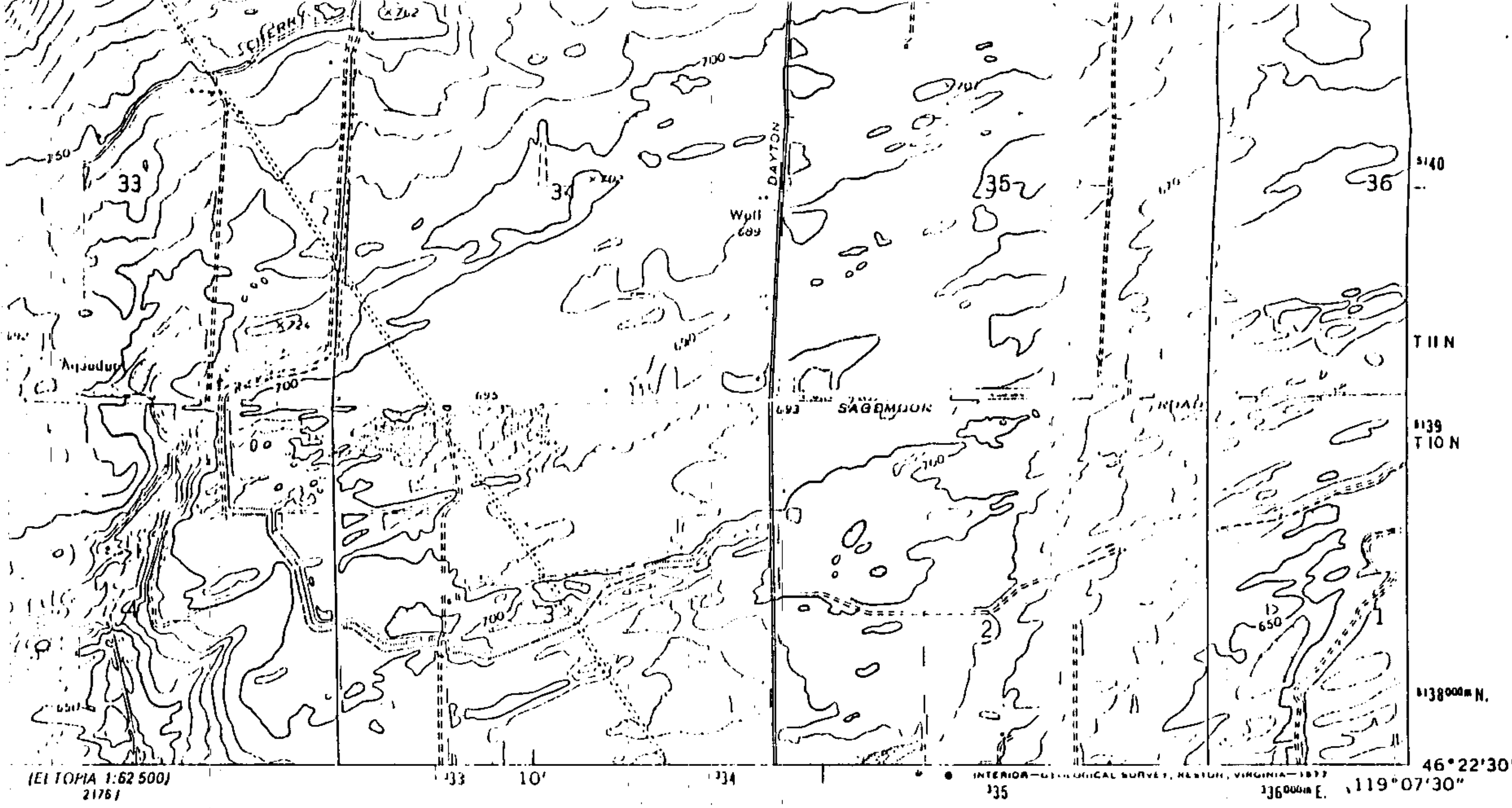
CCURACY STANDARDS
) 80225, OR RESTON, VIRGINIA 22092
)LS IS AVAILABLE ON REQUEST

RICHLAND, WASH.

SE/4 RICHLAND 15' QUADRANGLE
N4615—W11915/7.5

1978

AMS 2176 IV SE—SERIES V891



SCALE 1:24 000

0 1 MILE

3000 4000 5000 6000 7000 FEET

0 1 KILOMETER

ƆUR INTERVAL 10 FEET
S REPRESENT 5-FOOT CONTOURS
ƆDETIC VERTICAL DATUM OF 1929

VITH NATIONAL MAP ACCURACY STANDARDS
ƆY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
ƆPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

QUADRANGLE LOCATION

ROAD CLASSIFICATION

Primary highway, hard surface — Light-duty road, hard or improved surface

Secondary highway, hard surface — Unimproved road

Interstate Route — U. S. Route — State Route

MATHEWS CORNER, WASH.

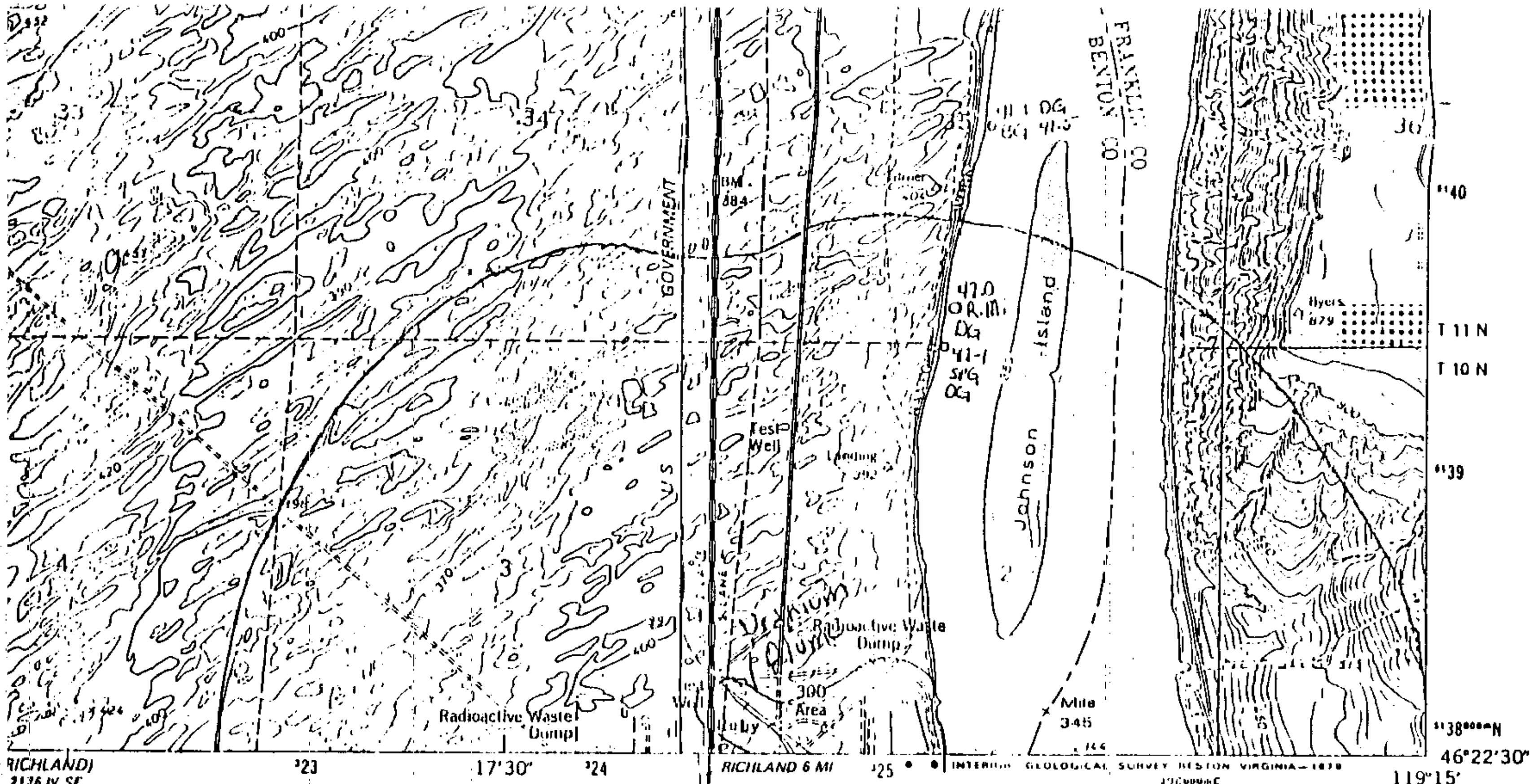
NW/4 ELTOPIA 15′ QUADRANGLE

N4622.5—W11907.5/7.5

1975

AMS 2176 I NW—SERIES V891

3
36123



LE 1:24 000

0 — 1 MILE

3000 4000 5000 6000 7000 FEET

0 — 1 KILOMETER

NTERVAL 10 FEET
VERTICAL DATUM OF 1929

IATIONAL MAP ACCURACY STANDARDS
NVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

WASHINGTON

QUADRANGLE LOCATION

ROAD CLASSIFICATION

Primary highway, hard surface — Light-duty road, hard or improved surface

Secondary highway hard surface — Unimproved road

( ) Interstate Route   U S Route   ( ) State Route

WOODED ISLAND, WASH.

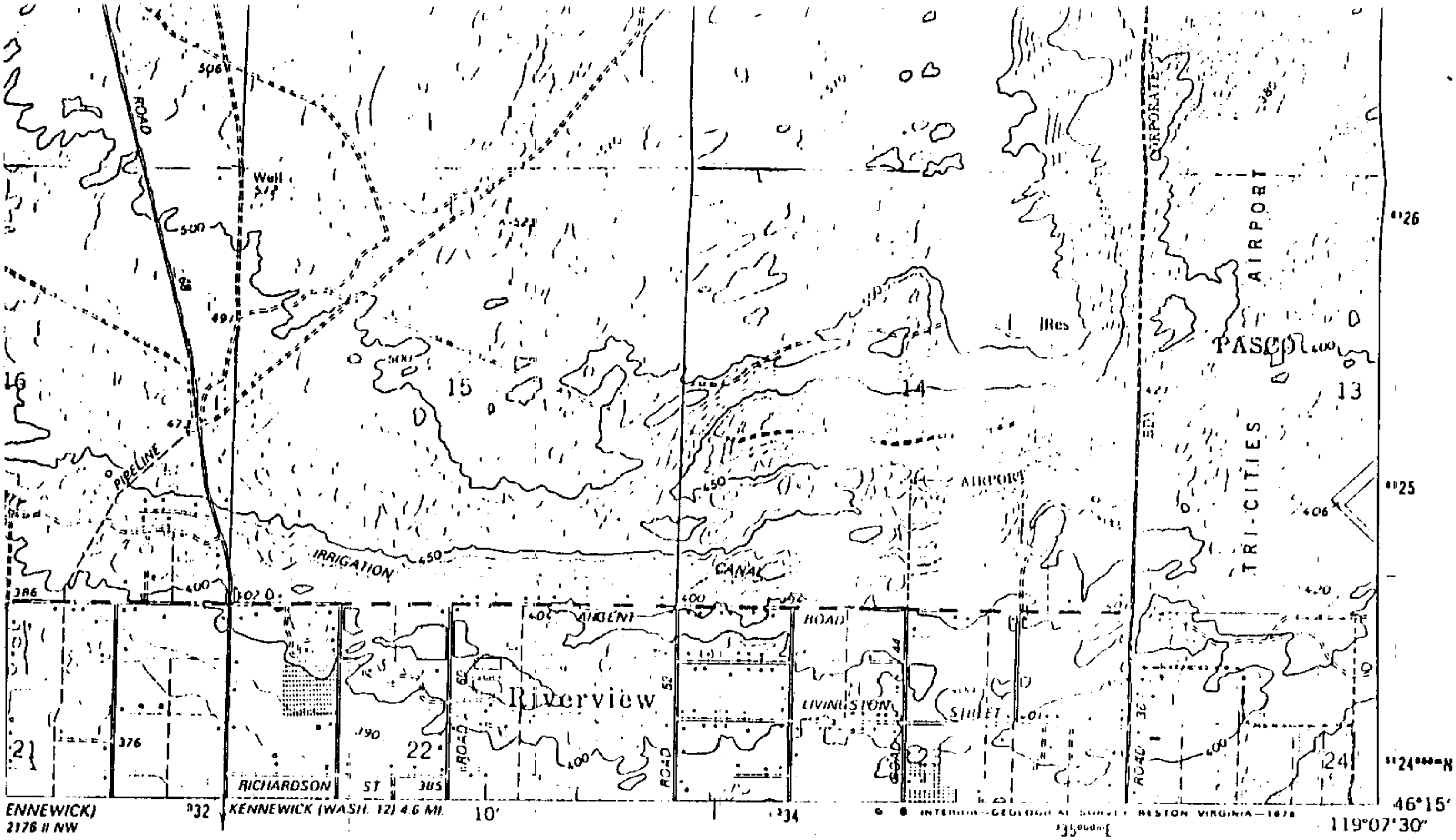
NE/4 RICHLAND 15' QUADRANGLE

N4622.5—W11915/7.5

1978

AMS 2176 IV NE—SERIES V891

4
36/23



LE 1:24 000

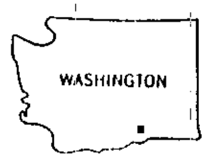
0 — 1 MILE

3000 4000 5000 6000 7000 FEET

0 — 1 KILOMETER

NTERVAL 10 FEET
VERTICAL DATUM OF 1929

ATIONAL MAP ACCURACY STANDARDS
NVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
MAPS AND SYMBOLS IS AVAILABLE ON REQUEST



QUADRANGLE LOCATION

ROAD CLASSIFICATION

Primary highway, hard surface

Light-duty road, hard or improved surface

Secondary highway, hard surface

Unimproved road

( ) Interstate Route ( ) U S Route ( ) State Route

COLUMBIA POINT, WASH.

SW/4 ELTOPIA 15' QUADRANGLE

N4615—W11907.5/7.5

1978

AMS 2178 I SW—SERIES V891

REFERENCE 12

Battelle Farm Operations Drawings RC-486 and RC-1147

File Note

Date: 10/29/87

From: RD Stenner RDStenner

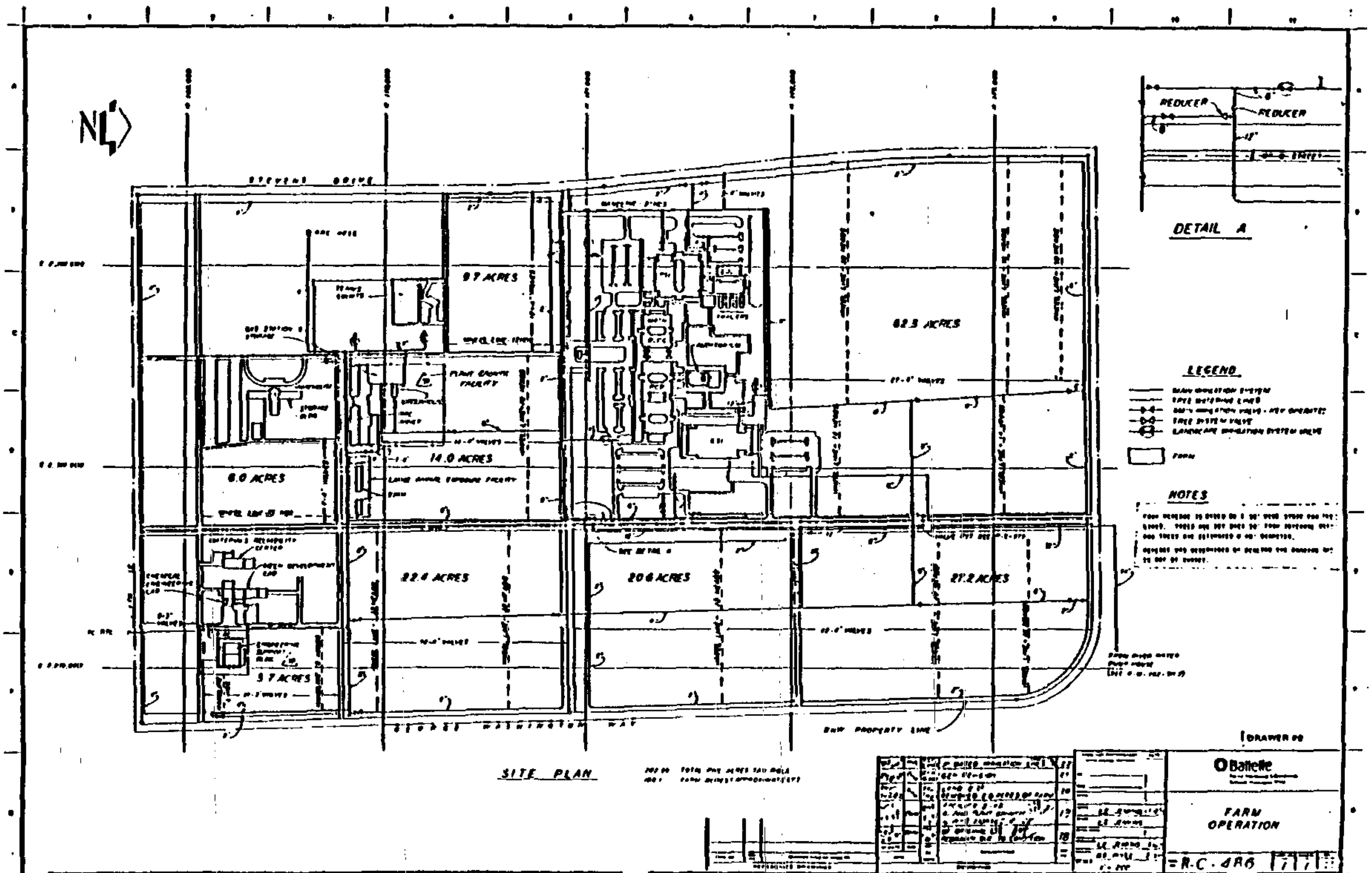
Subject: Telephone Conversation with Dale Schielke (PNL) Regarding Battelle Farm Operations Acerage

The Battele Farm Operations cover a total of 168.1 acres which are used for growing forage (food crops). The individual plot acrages are as follows:

62.5 acres
27.2 acres
20.6 acres
22.4 acres
5.7 acres
6.0 acres
14.0 acres
9.7 acres

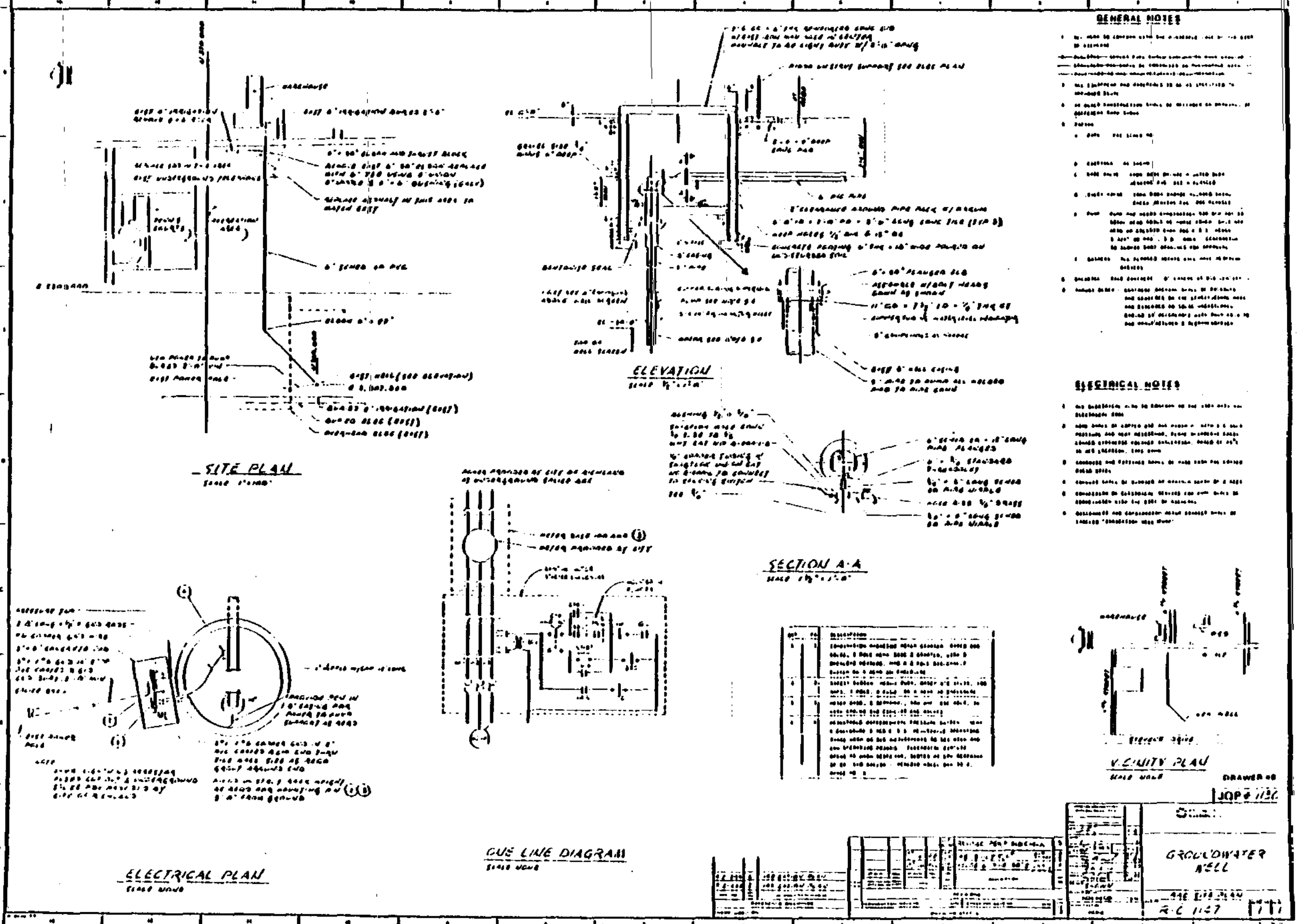
168.1 acres total

Ref. 12.1



REDUCER
REDUCER
DETAIL A
9.7 ACRES
82.3 ACRES
14.0 ACRES
8.0 ACRES
22.4 ACRES
20.6 ACRES
27.2 ACRES
3.7 ACRES
LEGEND
NOTES
SITE PLAN
Battelle
FARM OPERATION

9413218.0825 -



Ref. 12.2

---REFERENCE 13

Disposal of Hanford Defense High-Level Transuranic and Tank Wastes, March 1986, DOE/EIS-0113, Volume 1 has been designated a Metropolitan Statistical Area (MSA)[a] by the Bureau of the Census. A detailed review of area socioeconomics is given in DOE (1982), NRC (1982), Piott and Schau (1983) and Watson et al. (1984).

4.8.1 Economy and Work Force

The primary economic bases of the Tri-Cities MSA are the activities at Hanford, services, wholesale and retail trade and manufacturing (NRC 1982; Piott and Schau 1984). Dominant sectors of the economy in 1983 include services (27% of nonagricultural employment), wholesale and retail trade (20%), manufacturing (18%) and government (17%). The contract construction work force declined from 13,550 in 1981 (21% of the nonagricultural total) to 5,620 (10% of the nonagricultural total) in December 1983 (Piott and Schau 1983, 1984). Much of this decline was due to the completion, deferral, or cancellation of nuclear power plant construction. The Washington Public Power Supply System (WPPSS), the major non-DOE-related employer at Hanford, had about 2,200 employees as of March 1984. This is expected to decline to about 1,600 after Unit 2 becomes fully operational. About 13,000 persons are employed on DOE-related projects at Hanford (July 1983). Agricultural employment in Benton and Franklin Counties varies seasonally from a low of about 2,000 to a high of about 6,000 (Piott and Schau 1983).

The average annual per capita income, including agricultural payrolls, was about $8,300 in 1982. As of September 1985, the unemployment within the Tri-Cities was 7.8% compared with 7.2% for the state and 6.9% for the nation (personal communication, Schau 1985).

Certain projects possibly could compete for workers employed in disposal of Hanford high-level and transuranic wastes. These include the construction of a basalt waste isolation facility for disposing of commercially generated radioactive waste (and perhaps defense waste), with a projected peak force of 1,100, and the expansion of Priest Rapids and Wanapum Dams, with a projected peak work force of 1,100.

From 1970 to 1982, housing units increased 94.3%, following increased population and employment that accompanied WPPSS projects in the mid-1970s (Watson et al. 1984). The number of housing units grew at an annual average rate of 7.8% from 1973 through 1981. Richland, Pasco, and Kennewick all have experienced sharp declines in housing growth since 1981 (Watson et al. 1984). Housing units in 1982 in the Tri-Cities totaled about 58,000 with 69% being single-family units, 20% multifamily units, and 11% mobile homes (Tri-Cities Real Estate 1983). The total vacancy rate in the Tri-Cities MSA in 1983 was about 8.6%, or 5,000 vacant housing units (Watson et al. 1984).

4.8.2 Population

There were about 340,000 people residing within an 80-km radius of the 200 Areas according to estimates based on the 1980 census (Figure 4.11). The projected population within an 80-km radius of the 200 Areas for 1990 is about 420,000 (Sommer et al. 1981).

(a) An MSA is a designated population nucleus and surrounding areas that are part of the same economic and social structure. It comprises a single city of 50,000 population or more plus the surrounding associated areas or is a generally urbanized area of more than 100,000 population. The MSA usually follows county boundaries.

Ref. 13.1

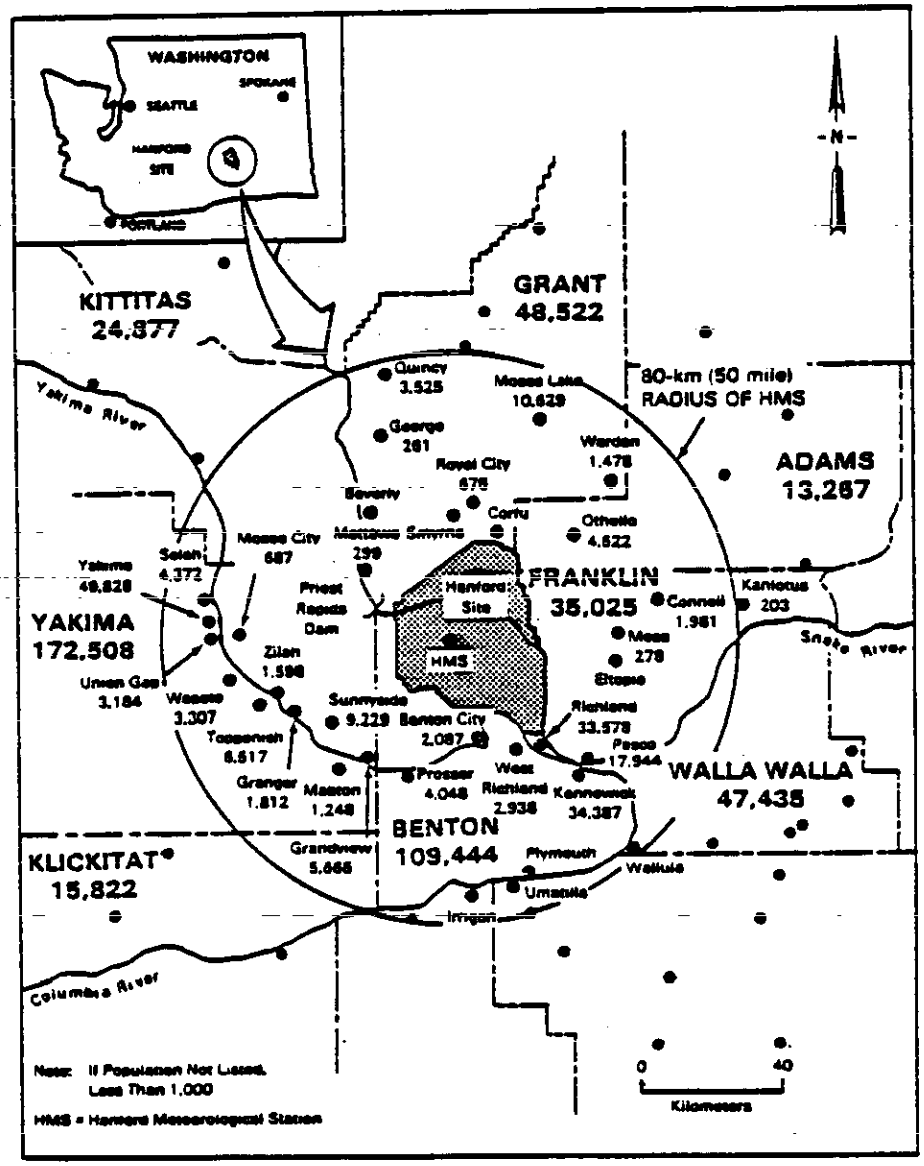


FIGURE 4.11. U.S. Census Populations for 1980 of Cities Within 80 km of the Hanford Meteorology Station (DOE 1982a)

The estimated population of Benton and Franklin Counties from 1981 to 1990 varies from a decline of about 8% to an increase of about 8%, depending on different assumed economic factors. These factors include the restart of construction of WPPSS reactors, possible changes in agricultural growth, or the start of new DOE-related projects (Watson et al. 1984).

REFERENCE 14

<u>Investigation of Ground Water Seepage from the Hanford Shoreline of the Columbia River</u>, PNL-5289, November 1984

PNL-5289
UC-41, 11

9413218.0836

Investigation of Ground-Water Seepage from the Hanford Shoreline of the Columbia River

W. D. McCormack
J. M. V. Carlile

November 1984

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute

Battelle

PNL-5289

Ref. 14.1

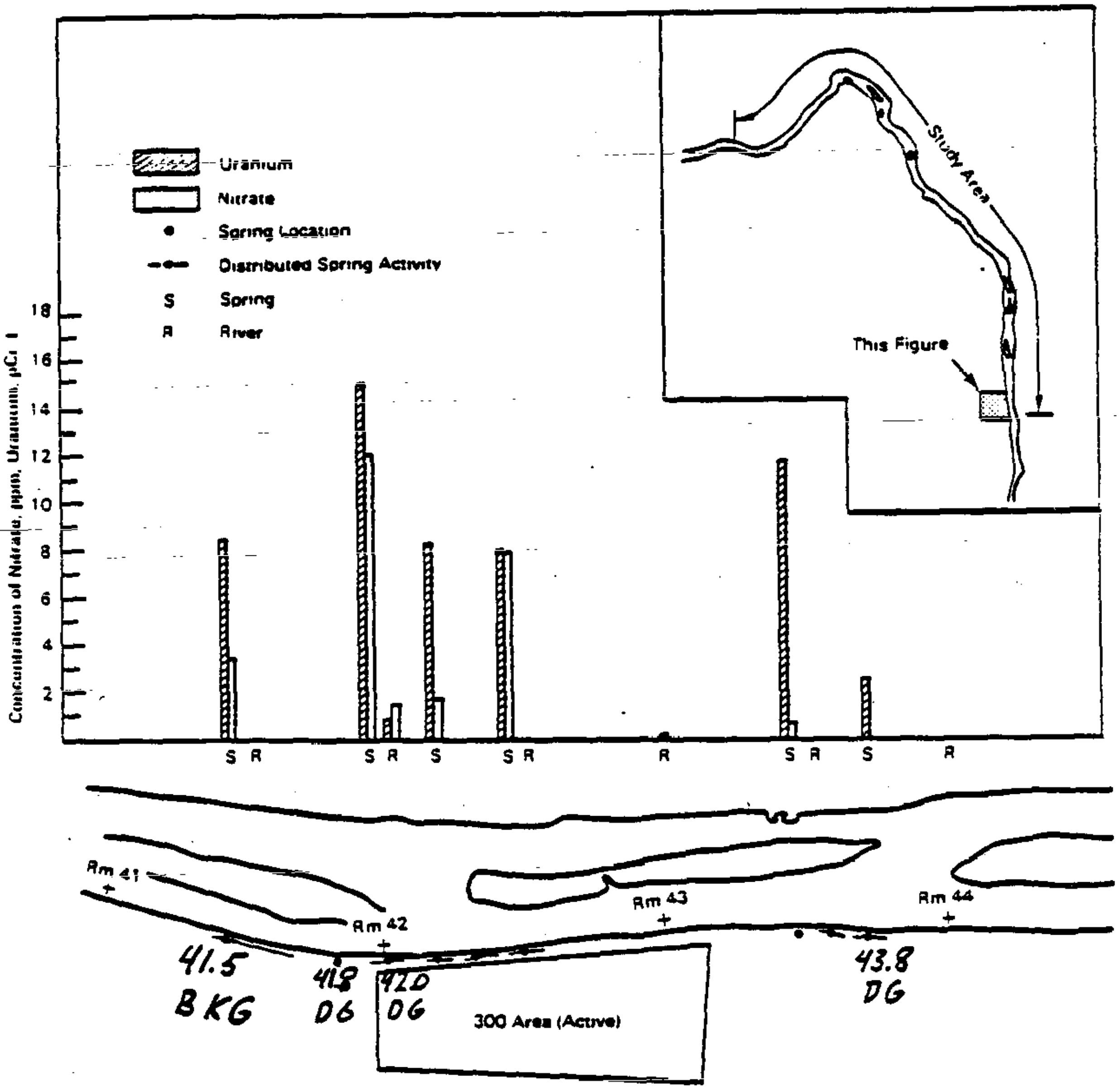


FIGURE 6. Locations and Analytical Results for Spring and River Samples - River Mile 41.5 through River Mile 44

TABLE A.1. Shoreline Inspection Record (Cont'd.)

River Mile Location	Spring Designation	Inspection Date/Time	Description
34.0	34-1	12:50	50 y DS[b] Cable crossing, saturated sand between cobble, appearance of recent flow
34.9	34-2	1:10	saturated above high water mark
	34-3	1:15	surface flow observed, saturated above high water, 50 y DS 34-2, 100 y US[a] RM[c] 35
	34-4		substantial standing water on bank
35.6	35-1	11-15-82/ 9:15 a.m.	moderate flow located in back eddy on sandy shore, 150 ft DS 1st WPPSS intake - small ponds 100 y DS 2nd intake
36	35-2		low flow, broad seepage on sandy bank, pond in woods US, located in back eddy
36.75	36-1	10:45	9.3°C, low flow, continuous several hundred feet DS, 200 y DS powerlines, sandy and rocky
37.1	37-1	10:46	moderate flow, rocky shoreline located in slough, continuous 25 y DS, rocky shore
37.5	37-2	11:00	high discharge, 5 springs 10 y US and DS from stake, sandy shore with cobbles and boulders
38.25	38-1	11:42	heavy flow, 75 y continuous, muddy, source below boulders
38.8	38-10	11:43	7.9°C, low flow, sandy beach, muskrat and beaver ditches, flow from ditches, 250 y US RM 39
39.25	39-1	12:50	several springs in small ditches flowing onto sandy beach and pools 6.9°C
40.0	40-1	1:30	8.6°C, low flow, sandy rocky beach, 25 y DS RM 40
	40-2	1:35	11.1°C, low flow, rocky shore, 100 ft DS 40-1
40.75	40-3	2.09	10.0°C, low flow, emanates under boulder at river's edge
	40-4	2:10	10.3°C, low flow, trickles from rocky shore at river's edge, 300 y US RM 41
41.5	41-1	2:44	14.3°C, low to moderate flow, continuous trickles on sandy beaches for several hundred ft DS of 41.75
41.8	41-2	2:57	13.6°C, moderate flow sandy beaches below bank side cut, swallows nests
42.0	42-1	11-19-82/ 8:18 a.m.	13.9°C, moderate flow, continuous 20 y US and 30 y DS, sandy muddy shore
	42-2	8:25	15.2°C, heavy flow, sandy muddy shore, continuous 30 y US and 50 y DS to point in river, no trespass sign, 100 y DS RM 42-at point huge flow at 19°C 12-12-82/10:00 a.m.
42.25	42-3	8:48	13.6°C, moderate flow, emanates from sandy mud, small spring, boulders and cobbles surrounded by patches of mud
	42-4	9:03	15.1°C, heavy flow continuous 25 y US and 50 y DS, 100 ft US from tree - final half mile of RM 42, intermittant springs 10.8°C - note to 42-4 at locations of historic 300 Area Springs #1
43.6	43-1	10:23	11.6°C, moderate flow, rocky shoreline, 50 y DS from boat ramp, 250 y US POB
43.75	43-2	10:32	11.6°C, moderate flow, continuous 10 y US to POB 100 y DS, rocky shoreline
43.8	43-3	10:45	12.1°C, moderate discharge, sandy muddy beach, intermittant cobble, continuous along beach DS, trickles and percolation

(a) US - Upstream
(b) DS - Downstream
(c) RM - River Mile

TABLE C.1. (contd)

Sample Collection				Analyses			
River Mile Location[a]	Sample ID	Sample Size	Date/Time Collected	^3H, pCi/ℓ ±2σ	NO_3, ppm	U, pCi/ℓ ± 2σ	Comments
29.0	29.0 RW[c]	1ℓ	01-22-83/1240	$(1.01\times10^2 \pm 2.11\times10^2)$[f]	0.71		
		1ℓ	09-11-83/1119	$4.11\times10^3 \pm 2.75\times10^2$	0.24		2 ℓ for 27/29 comp.
	29-0 Sp[d]	1ℓ	01-22-83/1255	$1.63\times10^3 \pm 2.34\times10^2$	2.65		new location-beach below RM 29
	27/29 comp. RW[e]	10ℓ	01-22-83/1430	$(1.23\times10^4 \pm 3.60\times10^4)$	2.65		2 ℓ for 27/29 comp.
		10ℓ	09-11-83/1221	$1.17\times10^4 \pm 3.74\times10^2$	0.35		
29.5	29.5 RW	1ℓ	09-11-83/1100	$2.56\times10^3 \pm 2.48\times10^2$	<0.02		2.5 ℓ for 29/31 comp.
30.0	30.0 RW	1ℓ	09-11-83/1033	$2.32\times10^3 \pm 2.44\times10^2$	0.15		2.5 ℓ for 29/31 comp.
	30-1 Sp	1ℓ	09-11-83/1025	$2.73\times10^3 \pm 2.52\times10^2$	3.14		20.4°C
30.5	30.5 RW	1ℓ	09-11-83/1012	$2.73\times10^3 \pm 2.51\times10^2$	0.05		2.5 ℓ for 29/31 comp.
31.0	31.0 RW	1ℓ	09-11-83/1009	$9.38\times10^2 \pm 2.20\times10^2$	0.05		2.5 ℓ for 29/31 comp.
	31-1 Sp	1ℓ	09-11-83/1005	$(1.57\times10^2 \pm 2.02\times10^2)$	5.25		15.8°C
	29/31 comp. RW	10ℓ	09-11-83/1100	$2.07\times10^3 \pm 2.39\times10^2$	0.26		
31.5	31.5 RW	1ℓ	09-11-83/0946	$6.86\times10^2 \pm 2.13\times10^2$	0.15		2.5 ℓ for 31/33 comp.
31.75	31-5 Sp	1ℓ	09-11-83/0950	$(1.90\times10^2 \pm 2.02\times10^2)$	2.64		17.4°C
32.0	32.0 RW	1ℓ	09-11-83/0923	$4.69\times10^2 \pm 2.09\times10^2$	0.09		2.5 ℓ for 31/33 comp.
32.5	32.5 RW	1ℓ	09-11-83/0912	$8.06\times10^2 \pm 2.16\times10^2$	0.11		2.5 ℓ for 31/33 comp.
	32-0 Sp	1ℓ	09-11-83/0927	$3.17\times10^2 \pm 2.06\times10^2$	1.78		17.8°C
33.0	33.0 RW	1ℓ	09-11-83/0900	$(1.30\times10^2 \pm 2.04\times10^2)$	0.05		2.5 ℓ for 31/33 comp.
	33-1 Sp	1ℓ	09-11-83/0900	$5.73\times10^2 \pm 2.11\times10^2$	0.75		17.9°C
	31/33 comp. RW	10ℓ	09-11-83/0950	$4.31\times10^2 \pm 2.08\times10^2$	0.15		
37.2	37-1 Sp	1ℓ	12-20-82/1047	$1.19\times10^3 \pm 2.30\times10^2$	5.31		6.7°C
38.25	38-1 Sp	1ℓ	12-20-82/1120	$4.72\times10^2 \pm 2.50\times10^2$	4.65		6.4°C
41.5	41.5 RW BKG	1ℓ	12-20-82/1235		0.62	0.408 ± 0.143	2 ℓ for 41.5/44 comp.; 6.2°C
41.8	41-1 Sp DG	1ℓ	12-20-82/1235		3.98	9.03 ± 3.16	11.1°C

(a-f) Key found at end of table.

Ref. 14.4

TABLE C.1. (contd)

Sample Collection				Analyses			
River Mile[a] Location	Sample ID	Sample Size	Date/Time Collected	^3H, pCi/ℓ ±2σ	NO_3, ppm	U, pCi/ℓ ± 2σ	Comments
42.0	42.0 RW DG	1ℓ	12-20-82/1235		2.12	1.57 ± 0.549	2 ℓ for 41.5/44 comp.
	42-1 Sp DG	1ℓ	12-20-82/1235		12.6	15.4 ± 5.40	11.8°C
		1ℓ	01-22-83/1530			19.0 ± 6.64	13.7°C
42.25	42-2 Sp[d]	1ℓ	12-20-82/1305		2.21	16.2 ± 5.67	11.2°C
		1ℓ	01-22-83/1500		--	8.72 ± 3.05	17.1°C
42.5	42.5 RW[c]	1ℓ	12-20-82/1314		0.26	0.612 ± 0.214	2 ℓ for 41.5/44 comp.
	42-4 Sp	1ℓ	12-20-82/1314		8.41	8.35 ± 2.92	6.6°C
		1ℓ	01-22-83/1515			8.38 ± 2.93	17.3°C
43.0	43.0 RW	1ℓ	12-20-82/1327		0.75	0.401 ± 0.140	2 ℓ for 41.5/44 comp.
43.5	43.5 RW	1ℓ	12-20-82/1340		0.26	0.325 ± 0.114	2 ℓ for 41.5/44 comp.
	43-1 Sp	1ℓ	12-20-82/1340		1.15	12.2 ± 4.26	7.8°C
43.8	43-3 Sp DG	1ℓ	12-20-82/1359		0.44	2.99 ± 1.05	10.1°C
44.0	44.0 RW	1ℓ	12-20-82/1350		0.18	0.391 ± 1.37	2 ℓ for 41.5/44 comp.
	41.5/44 comp. RW[e]	10ℓ	12-20-82/1350		0.66	0.746 ± 0.261	

(a) River mile locations based on markers indicating shoreline distance downstream from Vernita Bridge.
(b) BKG denotes "background" river sample collected from river surface at the middle of the river channel away from Hanford Shoreline.
(c) RW denotes river water sample collected from surface within 2 to 4 meters of Hanford shoreline.
(d) Sp denotes river-bank spring sample.
(e) Comp. RW denotes composite river water sample comprised of aliquots from immediately preceding sample locations.
(f) Parenthesis enclosing a value indicates that the radionuclide was not detectable; i.e., the value was less than its two-standard deviation (counting error) or the value was negative. (It is not uncommon for individual measurements of environmental radioactivity to result in values of zero or negative numbers due to subtracting out instrumental background.)

Ref. 14.5

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Killifish, Pahrump	*Empetrichthys latos*	U.S.A. (NV)	do	E	1	NA	NA
Logperch, Conasauga	*Percina jenkinsi*	U.S.A. (GA, TN)	do	E	196	17.95(e)	NA
Madtom, Scioto	*Noturus trautmani*	U.S.A. (OH)	do	E	10	NA	NA
Madtom, Smoky	*Noturus baileyi*	U.S.A. (TN)	do	E	183	17.95(e)	NA
Madtom, yellowfin	*Noturus flavipinnis*	U.S.A. (GA, TN, VA)	do	T	28	17.95(e)	17.44(c)
Nekogigi (catfish)	*Coreobagrus ichikawai*	Japan	do	E	3	NA	NA
Pupfish, Ash Meadows Amargosa	*Cyprinodon nevadensis mionectes*	U.S.A. (NV)	do	E	117E, 127E, 130	17.95(e)	NA
Pupfish, Comanche Springs	*Cyprinodon elegans*	U.S.A. (TX)	do	E	1	NA	NA
Pupfish, desert	*Cyprinodon macularius*	U.S.A. (AZ, CA) Mexico	do	E	222	17.95(e)	NA
Pupfish, Devils Hole	*Cyprinodon diabolis*	U.S.A. (NV)	do	E	1	NA	NA
Pupfish, Leon Springs	*Cyprinodon bovinus*	U.S.A. (TX)	do	E	102	17.95(e)	NA
Pupfish, Owens	*Cyprinodon radiosus*	U.S.A. (CA)	do	E	1	NA	NA
Pupfish, Warm Springs	*Cyprinodon nevadensis pectoralis*	U.S.A. (NV)	do	E	2	NA	NA
Shiner, beautiful	*Notropis formosus*	U.S.A. (AZ, NM), Mexico	do	T	157	17.95(e)	17.44(g)
Spikedace	*Meda fulgida*	do	do	T	236	NA	17.44(p)
Spinedace, Big Spring	*Lepidomeda mollispinis pratensis*	U.S.A. (NV)	do	T	173	17.95(e)	17.44(f)
Spinedace, White River	*Lepidomeda albivallis*	do	do	E	203	17.95(e)	NA
Springfish, Hiko White River	*Crenichthys baileyi grandis*	do	do	E	206	17.95(e)	NA
Springfish, Railroad Valley	*Crenichthys nevadae*	do	do	T	224	17.95(e)	17.44(n)
Springfish, White River	*Crenichthys baileyi baileyi*	do	do	E	206	17.95(e)	NA
Squawfish, Colorado	*Ptychocheilus lucius*	U.S.A. (AZ, CA, CO, NM, NV, UT, WY), Mexico.	Entire, except Salt and Verde R. drainages, AZ.	E	1, 193	NA	NA
Do	do	do	Salt and Verde R. drainages, AZ.	XN	193	NA	17.84(b)
Stickleback, unarmored threespine	*Gasterosteus aculeatus williamsoni*	U.S.A. (CA)	Entire	E	2	NA	NA
Sturgeon, shortnose	*Acipenser brevirostrum*	U.S.A. and Canada (Atlantic Coast)	do	E	1	NA	NA
Sucker, June	*Chasmistes liorus*	U.S.A. (UT)	do	E	223	17.95(e)	NA
Sucker, Modoc	*Catostomus microps*	U.S.A. (CA)	do	E	184	17.95(e)	NA
Sucker, Warner	*Catostomus warnerensis*	U.S.A. (OR)	do	T	205	17.95(e)	17.44(f)
Tango, Miyako (Tokyo bitterling)	*Tanakia tanago*	Japan	do	E	3	NA	NA
Temolek, Ikan (minnow)	*Probarbus jullieni*	Thailand, Cambodia, Vietnam, Malaysia, Laos.	do	E	15	NA	NA
Topminnow, Gila	*Poeciliopsis occidentalis*	U.S.A. (AZ, NM), Mexico	do	E	1	NA	NA
Totoaba (seatrout or weakfish)	*Cynoscion macdonaldi*	Mexico (Gulf of California)	do	E	45	NA	NA
Trout, Apache	*Salmo apache*	U.S.A. (AZ)	do	T	1, 6	NA	17.44(a)
Trout, Gila	*Salmo gilae*	U.S.A. (AZ, NM)	do	E	1	NA	NA
Trout, greenback cutthroat	*Salmo clarki stomias*	U.S.A. (CO)	do	T	1, 36	NA	17.44(f)
Trout, Lahontan cutthroat	*Salmo clarki henshawi*	U.S.A. (CA, NV)	do	T	2, 8	NA	17.44(a)
Trout, Little Kern golden	*Salmo aguabonita whitei*	U.S.A. (CA)	do	T	37	17.95(e)	17.44(e)
Trout, Paiute cutthroat	*Salmo clarki seleniris*	do	do	T	1, 6	NA	17.44(a)

Woundfin	*Plagopterus argentissimus*	U.S.A. (AZ, NV, UT)	Entire, except Gila R. drainage, AZ, NM.	E	2, 193	NA	NA
Do	do	do	Gila R. drainage AZ, NM.	XN	193	NA	17.84(b)
SNAILS							
Snail, Chittenango ovate amber	*Succinea chittenangoensis*	U.S.A. (NY)	NA	T	41	NA	NA
Snail, flat-spired three-toothed	*Triodopsis platysayoides*	U.S.A. (WV)	NA	T	41	[illegible]	[illegible]
Snail, Iowa Pleistocene	*Discus macclintocki*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Trout, Paiute cutthroat .... Salmo clarki seleniris

Woundfin	*Plagopterus argentissimus*	U.S.A. (AZ, NV, UT)	Entire, except Gila R. drainage, AZ, NM.	E	2, 193	NA	NA
Do	do	do	Gila R. drainage AZ, NM.	XN	193	NA	17.84(b)
SNAILS							
Snail, Chittenango ovate amber	*Succinea chittenangoensis*	U.S.A. (NY)	NA	T	41	NA	NA
Snail, flat-spired three-toothed	*Triodopsis platysayoides*	U.S.A. (WV)	NA	T	41	NA	NA
Snail, Iowa Pleistocene	*Discus macclintocki*	U.S.A. (IA)	NA	E	41	NA	NA
Snail, Manus Island tree	*Papustyla pulcherrima*	Pacific Ocean: Admiralty Is. (Manus Is.)	NA	E	3	NA	NA
Snail, noonday	*Mesodon clarki nantahala*	U.S.A. (NC)	NA	T	41	NA	NA
Snail, Oahu tree	*Achatinella* spp. (all species)	U.S.A. (HI)	NA	E	108, 112	NA	NA
Snail, painted snake coiled forest	*Anguispira picta*	U.S.A. (TN)	NA	T	41	NA	NA
Snail, Stock Island	*Orthalicus reses* (not incl. *nesodryas*)	U.S.A. (FL)	NA	T	41	NA	NA
Snail, Virginia fringed mountain	*Polygyriscus virginianus*	U.S.A. (VA)	NA	E	41	NA	NA
CLAMS							
Pearly mussel, Alabama lamp	*Lampsilis virescens*	U.S.A. (AL, TN)	NA	E	15	NA	NA
Pearly mussel, Appalachian monkeyface	*Quadrula sparsa*	U.S.A. (TN, VA)	NA	E	15	NA	NA
Pearly mussel, birdwing	*Conradilla caelata*	do	NA	E	15	NA	NA
Pearly mussel, Cumberland bean	*Villosa* (=*Micromya*) *trabalis*	U.S.A. (KY, TN)	NA	E	15	NA	NA
Pearly mussel, Cumberland monkeyface	*Quadrula intermedia*	U.S.A. (AL, TN, VA)	NA	E	15	NA	NA
Pearly mussel, Curtis'	*Epioblasma* (=*Dysnomia*) *florentina curtisi.*	U.S.A. (MO)	NA	E	15	NA	NA
Pearly mussel, dromedary	*Dromus dromas*	U.S.A. (TN, VA)	NA	E	15	NA	NA
Pearly mussel, green-blossom	*Epioblasma* (=*Dysnomia*) *torulosa gubernaculum.*	do	NA	E	15	NA	NA
Pearly mussel, Higgins' eye	*Lampsilis higginsi*	U.S.A. (IL, IA, MN, MO, NE, WI)	NA	E	15	NA	NA
Pearly mussel, Nicklin's	*Megalonaias nicklineana*	Mexico	NA	E	15	NA	NA
Pearly mussel, orange-footed	*Plethobasus cooperianus*	U.S.A. (AL, IN, IA, KY, OH, PA, TN)	NA	E	15	NA	NA
Pearly mussel, pale lilliput	*Toxolasma* (=*Carunculina*) *cylindrellus*	U.S.A. (AL, TN)	NA	E	15	NA	NA
Pearly mussel, pink mucket	*Lampsilis orbiculata*	U.S.A. (AL, IL, IN, KY, MO, OH, PA, TN, WV).	NA	E	15	NA	NA
Pearly mussel, Tampico	*Cyrtonaias tampicoensis tecomatensis*	Mexico	NA	E	15	NA	NA
Pearly mussel, tubercled-blossom	*Epioblasma* (=*Dysnomia*) *torulosa torulosa.*	U.S.A. (IL, IN, KY, TN, WV)	NA	E	15	NA	NA
Pearly mussel, turgid-blossom	*Epioblasma* (=*Dysnomia*) *turgidula*	U.S.A. (AL, TN)	NA	E	15	NA	NA
Pearly mussel, white cat's paw	*Epioblasma* (=*Dysnomia*) *sulcata delicata.*	U.S.A. (IN, MI, OH)	NA	E	15	NA	NA
Pearly mussel, white wartyback	*Plethobasus cicatricosus*	U.S.A. (AL, IN, TN)	NA	E	15	NA	NA
Pearly mussel, yellow-blossom	*Epioblasma* (=*Dysnomia*) *florentina florentina.*	U.S.A. (AL, TN)	NA	E	15	NA	NA
Pigtoe, fine-rayed	*Fusconaia cuneolus*	U.S.A. (AL, TN, VA)	NA	E	15	NA	NA
Pigtoe, rough	*Pleurobema plenum*	U.S.A. (IN, KY, TN, VA)	NA	E	15	NA	NA
Pigtoe, shiny	*Fusconaia edgariana*	U.S.A. (AL, TN, VA)	NA	E	15	NA	NA
Pocketbook, fat	*Potamilus* (=*Proptera*) *capax*	U.S.A. (AR, IN, MO, OH)	NA	E	15	NA	NA
Riffle shell, tan	*Epioblasma walkeri*	U.S.A. (KY, TN, VA)	NA	E	27	NA	NA

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
Spiny mussel, Tar River	*Elliptio (Canthyria) steinstansana*	U.S.A. (NC)	NA	E	186	NA	NA
CRUSTACEANS							
Amphipod, Hay's Spring	*Stygobromus hayi*	U.S.A. (DC)	NA	E	116	NA	NA
Crayfish, Nashville	*Orconectes shoupi*	U.S.A. (TN)	NA	E	242	NA	NA
Isopod, Madison Cave	*Antrolana lira*	U.S.A. (VA)	NA	T	123	NA	17.46(a)
Isopod, Socorro	*Thermosphaeroma (=Exosphaeroma) thermophilus.*	U.S.A. (NM)	NA	E	36	NA	NA
Shrimp, Kentucky cave	*Palaemonias ganteri*	U.S.A. (KY)	NA	E	136	17.95(h)	NA
INSECTS							
Beetle, delta green ground	*Elaphrus viridis*	U.S.A. (CA)	NA	T	100	17.95(i)	NA
Beetle, valley elderberry longhorn	*Desmocerus californicus dimorphus*	...do	NA	T	99	17.95(i)	NA
Butterfly, El Segundo blue	*Euphilotes (=Shijimiaeoides) battoides allyni.*	...do	NA	E	14	NA	NA
Butterfly, Lange's metalmark	*Apodemia mormo langei*	...do	NA	E	14	NA	NA
Butterfly, lotis blue	*Lycaeides argyrognomon lotis*	...do	NA	E	14	NA	NA
Butterfly, mission blue	*Icaricia icarioides missionensis*	...do	NA	E	14	NA	NA
Butterfly, Oregon silverspot	*Speyeria zerene hippolyta*	U.S.A. (OR, WA)	NA	T	85	17.95(i)	NA
Butterfly, Palos Verdes blue	*Glaucopsyche lygdamus palosverdesensis.*	U.S.A. (CA)	NA	E	96	17.95(i)	NA
Butterfly, San Bruno elfin	*Callophrys mossii bayensis*	...do	NA	E	14	NA	NA
Butterfly, Schaus swallowtail	*Heraclides (=Papilio) aristodemus ponceanus.*	U.S.A. (FL)	NA	E	13,156	NA	NA
Butterfly, Smith's blue	*Euphilotes (=Shijimiaeoides) enoptes smithi.*	U.S.A. (CA)	NA	E	14	NA	NA
Moth, Kern primrose sphinx	*Euproserpinus euterpe*	...do	NA	T	81	NA	NA
Naucorid, Ash Meadows	*Ambrysus amargosus*	U.S.A. (NV)	NA	T	181	17.95(i)	NA

EDITORIAL NOTE: For "When listed" citations, see list following; for symbols in "When listed" see below.
#—Indicates FR where species was delisted; relisting of the species is indicated by subsequent number(s).
E—Indicates Emergency rule publication (see FR document for effective dates); subsequent number(s) indicate FR final rule, if applicable under "When listed".

1—32 FR 4001; M
2—35 FR 16047; C
3—35 FR 8495; Ju
4—35 FR 18320; D
5—37 FR 6476; M
6—38 FR 14678; J
7—39 FR 44991; D
8—40 FR 29864; J
9—40 FR 31736; J
10—40 FR 44151;
11—40 FR 44418;
12—40 FR 47506;
13—41 FR 17740;
14—41 FR 22044;
15—41 FR 24064;
16—41 FR 45993;
17—41 FR 51021;
18—41 FR 51612;
19—41 FR 53034;
20—42 FR 2076; Ja
21—42 FR 2968; Ja
22—42 FR 15971, M
23—42 FR 28137; J
24—42 FR 28545; J
25—42 FR 37373; J
26—42 FR 40685; A
27—42 FR 42353; A
28—42 FR 45528; S
29—42 FR 58755; N
30—42 FR 60745; N
31—43 FR 3715; Ja
32—43 FR 4028; Ja
33—43 FR 4621; Fe
34—43 FR 6233; Fe
35—43 FR 9612; Ma
36—43 FR 12691; M
37—43 FR 15429; A
38—43 FR 16345; A
40—43 FR 20504; M
41—43 FR 28932; Ju
42—43 FR 32808; Ju
43—43 FR 34479; A
45—44 FR 21289; A
46—44 FR 23064; A
48—44 FR 29480; M
50—44 FR 37126; Ju
51—44 FR 37132; Ju
52—44 FR 42911; Ju
54—44 FR 49220; Au
55—44 FR 54007; Se
60—44 FR 59084; O
85—44 FR 69208; N
86—44 FR 70677; D
87—44 FR 75076; D
88—45 FR 18010; M
90—45 FR 21833; Ap
91—45 FR 24090; Ap
92—45 FR 27713; Ap
93—45 FR 28722; Ap
94—45 FR 35821; M
95—45 FR 44935; Ju
96—45 FR 44939; Ju
97—45 FR 47352; Ju
98—45 FR 47355; Ju
99—45 FR 52803; Au
100—45 FR 52807; A
102—45 FR 54678; A

1—32 FR 4001; March 11, 1967.
2—35 FR 16047; October 13, 1970.
3—35 FR 8495; June 2, 1970.
4—35 FR 18320; December 2, 1970.
5—37 FR 6476; March 30, 1972.
6—38 FR 14678; June 4, 1973.
7—39 FR 44991; December 30, 1974.
8—40 FR 29864; July 16, 1975.
9—40 FR 31736; July 28, 1975.
10—40 FR 44151; September 25, 1975.
11—40 FR 44418; September 26, 1975.
12—40 FR 47506; October 9, 1975.
13—41 FR 17740; April 28, 1976.
14—41 FR 22044; June 1, 1976.
15—41 FR 24064; June 14, 1976.
16—41 FR 45993; October 19, 1976.
17—41 FR 51021; November 19, 1976.
18—41 FR 51612; November 23, 1976.
19—41 FR 53034; December 3, 1976.
20—42 FR 2076; January 10, 1977.
21—42 FR 2968; January 14, 1977.
22—42 FR 15971, March 24, 1977.
23—42 FR 28137; June 2, 1977.
24—42 FR 28545; June 3, 1977.
25—42 FR 37373; July 21, 1977.
26—42 FR 40685; August 11, 1977.
27—42 FR 42353; August 23, 1977.
28—42 FR 45528; September 9, 1977.
29—42 FR 58755; November 11, 1977.
30—42 FR 60745; November 29, 1977.
31—43 FR 3715; January 27, 1978.
32—43 FR 4028; January 31, 1978.
33—43 FR 4621; February 3, 1978.
34—43 FR 6233; February 14, 1978.
35—43 FR 9612; March 9, 1978.
36—43 FR 12691; March 27, 1978.
37—43 FR 15429; April 13, 1978.
38—43 FR 16345; April 18, 1978.
40—43 FR 20504; May 12, 1978.
41—43 FR 28932; July 3, 1978.
42—43 FR 32808; July 28, 1978.
43—43 FR 34479; August 4, 1978.
45—44 FR 21289; April 10, 1979.
46—44 FR 23064; April 17, 1979.
48—44 FR 29480; May 21, 1979.
50—44 FR 37126; June 25, 1979.
51—44 FR 37132; June 25, 1979.
52—44 FR 42911; July 20, 1979.
54—44 FR 49220; August 21, 1979.
55—44 FR 54007; September 17, 1979.
60—44 FR 59084; October 12, 1979.
85—44 FR 69208; November 30, 1979.
86—44 FR 70677; December 7, 1979.
87—44 FR 75076; December 18, 1979.
88—45 FR 18010; March 20, 1980.
90—45 FR 21833; April 2, 1980.
91—45 FR 24090; April 8, 1980.
92—45 FR 27713; April 23, 1980.
93—45 FR 28722; April 30, 1980.
94—45 FR 35821; May 28, 1980.
95—45 FR 44935; July 2, 1980.
96—45 FR 44939; July 2, 1980.
97—45 FR 47352; July 14, 1980.
98—45 FR 47355; July 14, 1980.
99—45 FR 52803; August 8, 1980.
100—45 FR 52807; August 8, 1980.
102—45 FR 54678; August 15, 1980.
103—45 FR 55654; August 20, 1980.
105—45 FR 63812; September 25, 1980.
106—45 FR 65132; October 1, 1980.
108—46 FR 3178; January 13, 1981.
111—46 FR 11665; February 10, 1981.
112—46 FR 40025; August 6, 1981.
113—46 FR 40664; August 10, 1981.
114—47 FR 4204; January 28, 1982.
115—47 FR 5425; February 5, 1982.
117—47 FR 19995; May 10, 1982.
119—47 FR 31670; July 21, 1982.
123—47 FR 43701; October 4, 1982.
124—47 FR 43962; October 5, 1982.
125—47 FR 46093; October 15, 1982.
127—48 FR 612; January 5, 1983.
128—48 FR 1726; January 14, 1983.
129—48 FR 28464; June 22, 1983.
130—48 FR 40184; September 2, 1983.
131—48 FR 43043; September 21, 1983.
132—48 FR 46057; October 11, 1983.
134—48 FR 46336; October 12, 1983.
135—48 FR 46341; October 12, 1983.
136—48 FR 49249; October 25, 1983.
137—49 FR 1058; January 9, 1984.
138—49 FR 1994; January 17, 1984.
139—49 FR 2783; January 23, 1984.
142—49 FR 7335; February 28, 1984.
143—49 FR 7394; February 29, 1984.
144—49 FR 7398; February 29, 1984.
145—49 FR 10526; March 20, 1984.
146—49 FR 14356; April 11, 1984.
149—49 FR 22334; May 29, 1984.
150—49 FR 27514; July 5, 1984.
156—49 FR 33885; August 27, 1984.
157—49 FR 34494; August 31, 1984.
159—49 FR 34504; August 31, 1984.
160—49 FR 34510; August 31, 1984.
161—49 FR 35954; September 13, 1984.
163—49 FR 43069; October 26, 1984.
164—49 FR 43969; November 1, 1984.
166—49 FR 45163; November 15, 1984.
168—49 FR 49639; December 21, 1984.
169—50 FR 1056; January 9, 1985.
170—50 FR 4226; January 30, 1985.
171—50 FR 4945; February 4, 1985.
173—50 FR 12302; March 28, 1985.
174—50 FR 12305; March 28, 1985.
181—50 FR 20785; May 20, 1985.
182—50 FR 21792; May 28, 1985.
183—50 FR 23884; June 6, 1985.
184—50 FR 24530; June 11, 1985.
185—50 FR 24653; June 12, 1985.
186—50 FR 25678; June 20, 1985.
188—50 FR 26575; June 27, 1985.
189—50 FR 27002; July 1, 1985.
193—50 FR 30194; July 24, 1985.
195—50 FR 31596; August 5, 1985.
196—50 FR 31603; August 5, 1985.
203—50 FR 37198; September 12, 1985.
205—50 FR 39117; September 27, 1985.
206—50 FR 39123; September 27, 1985.
210—50 FR 50308; December 10, 1985.
211—50 FR 50733; December 11, 1985.
212—50 FR 51252; December 16, 1985.
216—51 FR 6690; February 25, 1986.
222—51 FR 10850; March 31, 1986.

223—51 FR 10857; March 31, 1986.
224—51 FR 10864; March 31, 1986.
227—51 FR 16047; April 30, 1986.
228—51 FR 16482; May 2, 1986.
233—51 FR 17980; May 16, 1986.
236—51 FR 23781; July 1, 1986.
239—51 FR 27495; July 31, 1986.
241—51 FR 31422; September 3, 1986.
242—51 FR 34412; September 26, 1986.
246—51 FR 34425; September 26, 1986.

[48 FR 34182, July 27, 1983; 48 FR 34961, Aug. 2, 1983, as amended at 48 FR 39943, Sept. 2, 1983; 48 FR 46337, Oct. 12, 1983; 48 FR 52743, Nov. 22, 1983; 49 FR 1058, Jan. 9, 1984; 49 FR 33892, Aug. 27, 1984]

EDITORIAL NOTE: For additional FEDERAL REGISTER citations affecting the table in § 17.11(h), see the listing which follows the table.

EFFECTIVE DATE NOTE: At 51 FR 34412, 34425, Sept. 26, 1986, the table in § 17.11(h) was amended by adding "Shrew, Dismal Swamp southeastern" alphabetically under "Mammals" and adding "Crayfish, Nashville" alphabetically under "Crustaceans", effective October 27, 1986.

§ 17.12 Endangered and threatened plants.

(a) The list in this section contains the names of all species of plants which have been determined by the Services to be Endangered or Threatened. It also contains the names of species of plants treated as Endangered or Threatened because they are sufficiently similar in appearance to Endangered or Threatened species (see § 17.50 *et seq.*).

(b) The columns entitled "Scientific name" and "Common name" define the species of plant within the meaning of the Act. Although common names are included, they cannot be relied upon for identification of any specimen, since they may vary greatly in local usage. The Services shall use the most recently accepted scientific name. In cases in which confusion might arise, a synonym(s) will be provided in parentheses. The Services shall rely to the extent practicable on the *International Code of Botanical Nomenclature.*

(c) In the "Status" column the following symbols are used: "E" for Endangered, "T" for Threatened, and "E [or T] (S/A)" for similarity of appearance species.

(d) The other data in the list are nonregulatory in nature and are provided for the information of the reader. In the annual revision and compilation of this title, the following information may be amended without public notice: the spelling of species' names, historical range, footnotes, references to certain other applicable portions of this title, synonyms, and more current names. In any of these revised entries, neither the species, as defined in paragraph (b) of this section, nor its status may be changed without following the procedures of Part 424 of this title.

(e) The "Historic range" indicates the known general distribution of the species or subspecies as reported in the current scientific literature. The present distribution may be greatly reduced from this historic range. This column does not imply any limitation on the application of the prohibitions in the Act or implementing rules. Such prohibitions apply to all individuals of the plant species, wherever found.

(f)(1) A footnote to the FEDERAL REGISTER publication(s) listing or reclassifying a species is indicated under the column "When listed." Footnote numbers to §§ 17.11 and 17.12 are in the same numerical sequence, since plants and animals may be listed in the same FEDERAL REGISTER document. That document, at least since 1973, includes a statement indicating the basis for the listing, as well as the effective date(s) of said listing.

(2) The "Special rules" and "Critical habitat" columns provide a cross reference to other sections in Parts 17, 222, 226, or 227. The "Special rules" column will also be used to cite the special rules which describe experimental populations and determine if they are essential or nonessential. Separate listings will be made for experimental populations, and the status column will include the following symbols: "XE" for an essential experimental population and "XN" for a nonessential experimental population. The term "NA" (not applicable) appearing in either of these two columns indicates that there are no special rules and/or critical habitat for that particular species. However, all other appropriate rules in Parts 17, 217 through 227, and 402 still apply to that species. In addition, there may be other rules in this title that relate to

such plants, e.g., port-of-entry requirements. It is not intended that the references in the "Special rules" column list all the regulations of the two Services which might apply to the species or to the regulations of other Federal agencies or State or local governments.

(g) The listing of a particular taxon includes all lower taxonomic units (see § 17.11(g) for examples).

(h) The "List of Endangered and Threatened Plants" is provided below:

Species		Historic range	Status	When listed	Critical habitat	Special rules
Scientific name	Common name					
Agavaceae—Agave family:						
Agave arizonica	Arizona agave	U.S.A. (AZ)	E	147	NA	NA
Alismataceae—Water-plantain family:						
Sagittaria fasciculata	Bunched arrowhead	U.S.A. (NC, SC)	E	63	NA	NA
Amaranthaceae—Amaranth family:						
Achyranthes rotundata	None	U.S.A. (HI)	E	220	NA	NA
Annonaceae—Custard-apple family:						
Asimina tetramera	Four-petal pawpaw	U.S.A. (FL)	E	244	NA	NA
Deeringothamnus pulchellus	Beautiful pawpaw	do	E	244	NA	NA
Deeringothamnus rugelii	Rugel's pawpaw	do	E	244	NA	NA
Apiaceae—Parsley family:						
Oxypolis canbyi	Canby's dropwort	U.S.A. (DE, GA, MD, NC, SC).	E	217	NA	NA
Apocynaceae—Dogbane family:						
Cycladenia humilis var. jonesii	Jones cycladenia	U.S.A. (AZ, UT)	T	229	NA	NA
Asteraceae—Aster family:						
Argyroxiphium sandwicense ssp. sandwicense	'Ahinahina (Mauna Kea silversword)	U.S.A. (HI)	E	219	NA	NA
Bidens cuneata	Cuneate bidens	do	E	141	NA	NA
Chrysopsis floridana (= *Heterotheca floridana*)	Florida golden aster	U.S.A. (FL)	E	232	NA	NA
Dyssodia tephroleuca	Ashy dogweed	U.S.A. (TX)	E	152	NA	NA
Echinacea tennesseensis	Tennessee purple coneflower	U.S.A. (TN)	E	49	NA	NA
Enceliopsis nudicaulis var. corrugata	Ash Meadows sunray	U.S.A. (NV)	T	181	17.96(a)	NA
Erigeron maguirei var. maguirei	Maguire daisy	U.S.A. (UT)	E	202	NA	NA
Erigeron rhizomatus	Rhizome fleabane	U.S.A. (NM)	T	177	NA	NA
Grindelia fraxinopratensis	Ash Meadows gumplant	U.S.A. (CA, NV)	T	181	17.96(a)	NA
Hymenoxys texana	None	U.S.A. (TX)	E	218	NA	NA
Lipochaeta venosa	do	U.S.A. (HI)	E	73	NA	NA
Pityopsis ruthii (= *Heterotheca ruthii*, = *Chrysopsis ruthii*)	Ruth's golden aster	U.S.A. (TN)	E	191	NA	NA
Senecio franciscanus	San Francisco Peaks groundsel	U.S.A. (AZ)	T	137	17.96(a)	NA
Solidago shortii	Short's goldenrod	U.S.A. (KY)	E	201	NA	NA
Solidago spithamaea	Blue Ridge goldenrod	U.S.A. (NC, TN)	T	175	NA	NA
Stephanomeria malheurensis	Malheur wire-lettuce	U.S.A. (OR)	E	126	17.96(a)	NA
Townsendia aprica	Last Chance townsendia	U.S.A. (UT)	T	200	NA	NA
Berberidaceae—Barberry family:						
Mahonia sonnei (= *Berberis s.*)	Truckee barberry	U.S.A. (CA)	E	76	NA	NA
Betulaceae—Birch family:						
Betula uber	Virginia round-leaf birch	U.S.A. (VA)	E	30	NA	NA

Boraginaceae—Borage family:						
Amsinckia grandiflora	Large-flowered fiddleneck	U.S.A. (CA)	E	170	17.96(a)	NA
Brassicaceae—Mustard family:						
Arabis mcdonaldiana	McDonald's rock-cress	U.S.A. (CA)	E	44	NA	NA
Erysimum capitatum var. angustatum	Contra Costa wallflower	do	E	30	17.96(a)	NA
Thelypodium stenopetalum	Slender-petaled mustard	do	E	156	NA	NA
Buxaceae—Boxwood family:						
Buxus vahlii	Vahl's boxwood	U.S.A. (PR)	E	187	NA	NA
Cactaceae—Cactus family:						

Berberidaceae—Barberry family:						
Mahonia sonnei (=*Berberis s.*)	…kee barberry					
Betulaceae—Birch family:						
Betula uber	…nia round-leaf birch	U.S.A. (VA)	E	39	NA	NA
Boraginaceae—Borage family:						
Amsinckia grandiflora	Large-flowered fiddleneck	U.S.A. (CA)	E	179	17.96(a)	NA
Brassicaceae—Mustard family:						
Arabis macdonaldiana	McDonald's rock-cress	U.S.A. (CA)	E	44	NA	NA
Erysimum capitatum var. *angustatum*	Contra Costa wallflower	do	E	39	17.96(a)	NA
Thelypodium stenopetalum	Slender-petaled mustard	do	E	158	NA	NA
Buxaceae—Boxwood family:						
Buxus vahlii	Vahl's boxwood	U.S.A. (PR)	E	197	NA	NA
Cactaceae—Cactus family:						
Ancistrocactus tobuschii (=*Echinocactus t.*, *Mammillaria t.*)	Tobusch fishhook cactus	U.S.A. (TX)	E	80	NA	NA
Cereus eriophorus var. *fragrans*	Fragrant prickly-apple	U.S.A. (FL)	E	208	NA	NA
Cereus robinii	Key tree-cactus	U.S.A. (FL), Cuba	E	153	NA	NA
Coryphantha minima (=*C. nellieae*, *Escobaria n.*, *Mammillaria n.*)	Nellie cory cactus	U.S.A. (TX)	E	61	NA	NA
Coryphantha ramillosa	Bunched cory cactus	U.S.A. (TX), Mexico (Coahuila).	T	77	NA	NA
Coryphantha robbinsorum (=*Cochiseia r.*, *Escobaria r.*)	Cochise pincushion cactus	U.S.A. (AZ), Mexico (Sonora).	T	214	NA	NA
Coryphantha sneedii var. *leei* (=*Escobaria l.*, *Mammillaria l.*)	Lee pincushion cactus	U.S.A. (NM)	T	61	NA	NA
Coryphantha sneedii var. *sneedii* (=*Escobaria s.*, *Mammillaria s.*)	Sneed pincushion cactus	U.S.A. (TX, NM)	E	62	NA	NA
Echinocactus horizonthalonius var. *nicholii*	Nichol's Turk's head cactus	U.S.A. (AZ)	E	71	NA	NA
Echinocereus engelmannii var. *purpureus*	Purple-spined hedgehog cactus	U.S.A. (UT)	E	58	NA	NA
Echinocereus fendleri var. *kuenzleri* (=*E. kuenzleri*, *E. hempelii* of authors, not Fobe).	Kuenzler hedgehog cactus	U.S.A. (NM)	E	70	NA	NA
Echinocereus lloydii (=*E. roetteri* var. *l.*)	Lloyd's hedgehog cactus	U.S.A. (TX)	E	67	NA	NA
Echinocereus reichenbachii var. *albertii* (=*E. melanocentrus*)	Black lace cactus	do	E	68	NA	NA
Echinocereus triglochidiatus var. *arizonicus* (=*E. arizonicus*)	Arizona hedgehog cactus	U.S.A. (AZ)	E	62	NA	NA
Echinocereus triglochidiatus var. *inermis* (=*E. coccineus* var. *i.*, *E. phoeniceus* var. *i.*).	Spineless hedgehog cactus	U.S.A. (CO, UT)	E	63	NA	NA
Echinocereus viridiflorus var. *davisii* (=*E. davisii*)	Davis' green pitaya	U.S.A. (TX)	E	61	NA	NA
Neolloydia mariposensis (=*Echinocactus m.*, *Echinomastus m.*)	Lloyd's Mariposa cactus	U.S.A. (TX), Mexico (Coahuila).	T	77	NA	NA
Pediocactus bradyi (=*Toumeya b.*)	Brady pincushion cactus	U.S.A. (AZ)	E	63	NA	NA
Pediocactus knowltonii (=*P. bradyi* var. *k.* *Toumeya k.*)	Knowlton cactus	U.S.A. (NM, CO)	E	72	NA	NA
Pediocactus peeblesianus var. *peeblesianus* (=*Echinocactus p.*, *Navajoa p.*, *Toumeya p.*, *Utahia p.*).	Peebles Navajo cactus	U.S.A. (AZ)	E	69	NA	NA
Pediocactus sileri (=*Echinocactus s.*, *Utahia s.*)	Siler pincushion cactus	U.S.A. (AZ, UT)	E	64	NA	NA
Sclerocactus glaucus (=*Echinocactus g.*, *E. subglaucus*, *E. whipplei* var. *g.*, *Pediocactus g.*, *S. franklinii*, *S. whipplei* var. *g.*).	Uinta Basin hookless cactus	U.S.A. (CO, UT)	T	59	NA	NA
Sclerocactus mesae-verdae (=*Coloradoa m.*, *Echinocactus m.*, *Pediocactus m.*).	Mesa Verde cactus	U.S.A. (CO, NM)	T	75	NA	NA
Sclerocactus wrightiae (=*Pediocactus w.*)	Wright fishhook cactus	U.S.A. (UT)	E	58	NA	NA
Caryophyllaceae—Pink family:						
Schiedea adamantis	Diamond Head schiedea	U.S.A. (HI)	E	141	NA	NA

Species: Scientific name	Species: Common name	Historic range	Status	When listed	Critical habitat	Special rules
Chenopodiaceae—Goosefoot family:						
Nitrophila mohavensis	Amargosa niterwort	U.S.A. (CA)	E	181	17.96(a)	NA
Cistaceae—Rockrose family:						
Hudsonia montana	Mountain golden heather	U.S.A. (NC)	T	107	17.96(a)	NA
Crassulaceae—Stonecrop family:						
Dudleya traskiae	Santa Barbara Island liveforever	U.S.A. (CA)	E	30	NA	NA
Cucurbitaceae—Gourd family:						
Tumamoca macdougalii	Tumamoc globe-berry	U.S.A. (AZ), Mexico (Sonora).	E	226	NA	NA
Cupressaceae—Cypress family:						
Fitzroya cupressoides	Chilean false larch (=alerce)	Chile, Argentina	T	79	NA	NA
Cyperaceae—Sedge family:						
Carex specuicola	None	U.S.A. (AZ)	T	178	17.96(a)	NA
Ericaceae—Heath family:						
Arctostaphylos pungens var. *ravenii* (=*A. hookeri* ssp. *ravenii*)	Presidio (=Raven's) manzanita	U.S.A. (CA)	E	65	NA	NA
Rhododendron chapmanii	Chapman rhododendron	U.S.A. (FL)	E	47	NA	NA
Euphorbiaceae—Spurge family:						
Euphorbia (=*Chamaesyce*) *deltoidea* ssp. *deltoidea*	Spurge	U.S.A. (FL)	E	182	NA	NA
Euphorbia (=*Chamaesyce*) *garberi*	None	...do	T	182	NA	NA
Euphorbia skottsbergii var. *kalaeloana*	Ewa Plains 'akoko	U.S.A. (HI)	E	120	NA	NA
Jatropha costaricensis	Costa Rican jatropha	Costa Rica	E	184	NA	NA
Fabaceae—Pea family:						
Amorpha crenulata	Crenulate lead-plant	U.S.A. (FL)	E	182	NA	NA
Astragalus humillimus	Mancos milk-vetch	U.S.A. (CO, NM)	E	187	NA	NA
Astragalus perianus	Rydberg milk-vetch	U.S.A. (UT)	T	38	NA	NA
Astragalus phoenix	Ash Meadows milk-vetch	U.S.A. (NV)	T	181	17.96(a)	NA
Baptisia arachnifera	Hairy rattleweed	U.S.A. (GA)	E	39	NA	NA
Galactia smallii	Small's milkpea	U.S.A. (FL)	E	182	NA	NA
Hoffmannseggia tenella	Slender rush-pea	U.S.A. (TX)	E	209	NA	NA
Lotus dendroideus ssp. *traskiae* (=*L. scoparius* ssp. *t.*)	San Clemente Island broom	U.S.A. (CA)	E	28	NA	NA
Mezoneuron kavaiense	Uhiuhi	U.S.A. (HI)	E	236	NA	NA
Vicia menziesii	Hawaiian vetch	...do	E	30	NA	NA
Frankeniaceae—Frankenia family:						
Frankenia johnstonii	Johnston's frankenia	U.S.A. (TX), Mexico (Nuevo Leon).	E	166	NA	NA

Species: Scientific name	Species: Common name	Historic range	Status	When listed	Critical habitat	Special rules
Gentianaceae—Gentian family:						
Centaurium namophilum	Spring-loving centaury	U.S.A. (CA, NV)	T	181	17.96(a)	NA
Goodeniaceae—Goodenia family:						
Scaevola coriacea	Dwarf naupaka	U.S.A. (HI)	E	231	NA	NA
Hydrophyllaceae—Waterleaf family:						
Phacelia argillacea	Clay phacelia	U.S.A. (UT)	E	44	NA	NA
Phacelia formosula	North Park phacelia	U.S.A. (CO)	E	121	NA	NA

Vicia menziesii						
Frankeniaceae—Frankenia family:						
Frankenia johnstonii	Johnston' ...nia	U.S.A. (TX), Mexico (Nuevo Leon).	E	155	NA	NA
Gentianaceae—Gentian family:						
Centaurium namophilum	Spring-loving centaury	U.S.A. (CA, NV)	T	181	17.96(a)	NA
Goodeniaceae—Goodenia family:						
Scaevola coriacea	Dwarf naupaka	U.S.A. (HI)	E	231	NA	NA
Hydrophyllaceae—Waterleaf family:						
Phacelia argillacea	Clay phacelia	U.S.A. (UT)	E	44	NA	NA
Phacelia formosula	North Park phacelia	U.S.A. (CO)	E	121	NA	NA
Lamiaceae—Mint family:						
Acanthomintha obovata ssp. *duttonii*	San Mateo thornmint	U.S.A. (CA)	E	204	NA	NA
Dicerandra cornutissima	Longspurred mint	U.S.A. (FL)	E	207	NA	NA
Dicerandra frutescens	Scrub mint	...do	E	207	NA	NA
Dicerandra immaculata	Lakela's mint	...do	E	160	NA	NA
Haplostachys haplostachya var. *angustifolia*	None	U.S.A. (HI)	E	73	NA	NA
Hedeoma apiculatum	McKittrick pennyroyal	U.S.A. (TX, NM)	T	118	17.96(a)	NA
Hedeoma todsenii	Todsen's pennyroyal	U.S.A. (NM)	E	110, 112	17.96(a)	NA
Pogogyne abramsii	San Diego mesa mint	U.S.A. (CA)	E	44	NA	NA
Scutellaria montana	Large-flowered skullcap	U.S.A. (GA,TN)	E	234	NA	NA
Stenogyne angustifolia var. *angustifolia*	None	U.S.A. (HI)	E	73	NA	NA
Lauraceae—Laurel family:						
Lindera melissifolia	Pondberry	U.S.A. (AL, AR, FL, GA, LA, MO, MS, NC, SC).	E	240	NA	NA
Liliaceae—Lily family:						
Erythronium propullans	Minnesota trout lily	U.S.A. (MN)	E	221	NA	NA
Harperocallis flava	Harper's beauty	U.S.A. (FL)	E	57	NA	NA
Trillium persistens	Persistent trillium	U.S.A. (GA, SC)	E	39	NA	NA
Loasaceae—Loasa family:						
Mentzelia leucophylla	Ash Meadows blazing star	U.S.A. (NV)	T	181	17.96(a)	NA
Malvaceae—Mallow family:						
Abutilon menziesii	Ko'oloa'ula	U.S.A. (HI)	E	243	NA	NA
Callirhoe scabriuscula	Texas poppy-mallow	U.S.A. (TX)	E	100, 112	NA	NA
Hibiscadelphus distans	Kauai hau kuahiwi	U.S.A. (HI)	E	225	NA	NA
Iliamna corei	Peter's Mountain mallow	U.S.A. (VA)	E	230	NA	NA
Kokia cookei	Cooke's kokio	U.S.A. (HI)	E	74	NA	NA
Kokia drynarioides	Koki'o (=hau-hele'ula or Hawaii tree cotton).	...do	E	187	17.96(a)	NA
Malacothamnus clementinus	San Clemente Island bush-mallow	U.S.A. (CA)	E	28	NA	NA
Sidalcea pedata	Pedate checker-mallow	...do	E	158	NA	NA
Nyctaginaceae—Four-o'clock family:						
Mirabilis macfarlanei	MacFarlane's four-o'clock	U.S.A. (ID, OR)	E	86	NA	NA

Species: Scientific name	Species: Common name	Historic range	Status	When listed	Critical habitat	Special rules
Onagraceae—Evening-primrose family:						
Camissonia benitensis	San Benito evening-primrose	U.S.A. (CA)	T	172	NA	NA
Oenothera avita ssp. *eurekensis*	Eureka Valley evening-primrose	...do	E	38	NA	NA
Oenothera deltoides ssp. *howellii*	Antioch Dunes evening-primrose	...do	E	38	17.96(a)	NA
Orchidaceae—Orchid family:						
Isotria medeoloides	Small whorled pogonia	U.S.A. (CT, IL, MA, MD, ME, MI, MO, NC, NH, NJ, NY, PA, RI, SC, VA, VT), Canada (Ont.).	E	122	NA	NA
Spiranthes parksii	Navasota ladies'-tresses	U.S.A. (TX)	E	116	NA	NA
Papaveraceae—Poppy family:						
Arctomecon humilis	Dwarf bear-poppy	U.S.A. (UT)	E	78	NA	NA
Pinaceae—Pine family:						
Abies guatemalensis	Guatemalan fir (=pinabete)	Mexico, Guatemala, Honduras, El Salvador.	T	84	NA	NA
Poaceae—Grass family:						
Tuctoria mucronata (=*Orcuttia m.*)	Solano grass	U.S.A. (CA)	E	44	NA	NA
Panicum carteri	Carter's panicgrass	U.S.A. (HI)	E	133	17.96(a)	NA
Swallenia alexandrae	Eureka Dune grass	U.S.A. (CA)	E	38	NA	NA
Zizania texana	Texas wild-rice	U.S.A. (TX)	E	38	17.96(a)	NA
Polygalaceae—Milkwort family:						
Polygala smallii	Tiny polygala	U.S.A. (FL)	E	192	NA	NA
Polygonaceae—Buckwheat family:						
Eriogonum gypsophilum	Gypsum wild-buckwheat	U.S.A. (NM)	T	110, 112	17.96(a)	NA
Eriogonum ovalifolium var. *williamsiae*	Steamboat buckwheat	U.S.A. (NV)	E	237	NA	NA
Eriogonum pelinophilum	Clay-loving wild-buckwheat	U.S.A. (CO)	E	151	17.96(a)	NA
Primulaceae—Primrose family:						
Primula maguirei	Maguire primrose	U.S.A. (UT)	T	190	NA	NA
Ranunculaceae—Buttercup family:						
Aconitum noveboracense	Northern wild monkshood	U.S.A. (IA, NY, OH, WI)	T	38	NA	NA
Clematis socialis	Alabama leather flower	U.S.A. (AL)	E	245	NA	NA
Delphinium kinkiense	San Clemente Island larkspur	U.S.A. (CA)	E	26	NA	NA
Rhamnaceae—Buckthorn family:						
Gouania hillebrandii	None	U.S.A. (HI)	E	165	17.96(a)	NA

Rosaceae—Rose family:						
Cowania subintegra	Arizona cliffrose	U.S.A. (AZ)	E	148	NA	NA
Ivesia eremica	Ash Meadows ivesia	U.S.A. (NV)	T	161	17.96(a)	NA
Potentilla robbinsiana	Robbins' cinquefoil	U.S.A. (NH, VT)	E	104	17.96(a)	NA
Rubiaceae—Coffee family:						
Gardenia brighamii	Na'u (Hawaiian gardenia)	U.S.A. (HI)	E	186	NA	NA
Rutaceae—Citrus family:						
	St. Thomas prickly-ash	U.S.A. (PR, VI)	E	213	NA	NA

Rosaceae—Rose family:						
Cowania subintegra	Arizona cliffrose	U.S.A. (AZ)	E	146	NA	NA
Ivesia eremica	Ash Meadows ivesia	U.S.A. (NV)	T	181	17.96(a)	NA
Potentilla robbinsiana	Robbins' cinquefoil	U.S.A. (NH, VT)	E	104	17.96(a)	NA
Rubiaceae—Coffee family:						
Gardenia brighamii	Na'u (Hawaiian gardenia)	U.S.A. (HI)	E	196	NA	NA
Rutaceae—Citrus family:						
Zanthoxylum thomasianum	St. Thomas prickly-ash	U.S.A. (PR, VI)	E	213	NA	NA
Santalaceae—Sandalwood family:						
Santalum freycinetianum var. *lanaiense*	Lanai sandalwood or 'iliahi	U.S.A. (HI)	E	216	NA	NA
Sarraceniaceae—Pitcher plant family:						
Sarracenia oreophila	Green pitcher plant	U.S.A. (AL, GA, TN)	E	56, 89	NA	NA
Saxifragaceae—Saxifrage family:						
Ribes echinellum	Miccosukee gooseberry	U.S.A. (FL, SC)	T	190	NA	NA
Scrophulariaceae—Snapdragon family:						
Castilleja grisea	San Clemente Island Indian paintbrush	U.S.A. (CA)	E	28	NA	NA
Cordylanthus maritimus ssp. *maritimus*	Salt marsh bird's-beak	U.S.A. (CA), Mexico (Baja California).	E	44	NA	NA
Cordylanthus palmatus	Palmate-bracted bird's-beak	U.S.A. (CA)	E	235	NA	NA
Pedicularis furbishiae	Furbish lousewort	U.S.A. (ME), Canada (New Brunswick).	E	39	NA	NA
Solanaceae—Nightshade family:						
Goetzea elegans	Beautiful goetzea, matabuey	U.S.A. (PR)	E	176	NA	NA
Styracaceae—Styrax family:						
Styrax texana	Texas snowbells	U.S.A. (TX)	E	162	NA	NA
Taxaceae—Yew family:						
Torreya taxifolia	Florida torreya	U.S.A. (FL, GA)	E	140	NA	NA

EDITORIAL NOTE: For "When listed" citations, see list following; for symbols in "When listed" see below:

E—Indicates Emergency rule publication (see FR document for effective dates); subsequent number(s) indicate FR final rule, if applicable under "When listed".

REFERENCE 19

Memo to file from BW Mercer regarding Franklin County Drinking Water Wells, August 25, 1987

Battelle
Pacific Northwest Laboratories

Project Number ______

Internal Distribution

File/LB

Date August 25, 1987

To File

From B. W. Mercer David Lamar for BWM

Subject Drinking Water Wells in Franklin County within 3 Miles of the 200 Area Defined Boundary and within 3 miles of the 300 Area Defined Boundary

Mr. Clifford L. Bates of the Benton Franklin District Health Department was contacted on the above date for information on the number of drinking water wells within the subject boundaries. Mr. Bates has a map of Franklin County in his office showing the location and nitrate levels of drinking water wells that he is aware of. There may be other wells that have not been reported. The number of wells within 3 miles of the 200 Area defined boundary and within 3 miles of the 300 Area defined boundary are tabulated on the following pages which also give estimates of the number of people served.

BWM:DAL:dar

To File
August 25, 1987
Page 2

Wells within 3 Miles of 200 Area Plume in the Columbia River

Boundary: 1) North edge of T. 12 N. on an east-west line with Klamath Rd.

2) East boundary north-south along Taylor Flats Rd.

3) West boundary - Columbia River

4) ~~South boundary - Sagemoor Rd.~~

Total No. of wells within this boundary is 17 including private dwellings and community wells(3). Private single dwelling wells = 14.

No. of community wells (from State of Washington Public Water Supply System Listing)

		Permanent People		Migrant Farm Worker Residents
1.	Eppich Water System	12		8
2.	Cypress Gardens School	12		0
3.	Rio Vista Orchards	8		0
	TOTAL	32	8	= 40 people

assume 3 people to private single dwelling wells = 14 x 3.8 = 53.2 people

TOTAL = 95.2 people

To File
August 25, 1987
Page 3

Wells within 3 Miles of 300 Area Plume

Boundary: 1) North - along Dogwood Rd on line to river

2) East - along Taylor Flats Rd

3) West - along Columbia River

4) South - along Dent Rd and line to river

Total No. of wells within this boundary is 17 including both private single dwelling wells and community wells.

No. of community wells (from State of Washington Public Water Supply System Listing)

		No. People Served
1.	Cypress Gardens School	12
2.	Rio Vista Orchards	8
	TOTAL	20 people

assume 3.8 people at each single dwelling well:

15 wells x 3.8 people/well = 57 people

Total people single + community wells = 77 People

Gull, relict	*Larus relictus*	India, China	do	E	15	NA	NA
Hawk, Anjouan Island sparrow	*Accipiter francesii pusillus*	Indian Ocean: [illegible] Islands	do	E	3	NA	NA
Hawk, Galapagos	*Buteo galapagoensis*	Ecuador (Galapagos Islands)	do	E	3	NA	NA
Hawk, Hawaiian (=Io)	*Buteo solitarius*	U.S.A. (HI)	do	E	1	NA	NA
Hermit, hook-billed (hummingbird)	*Glaucis (=Ramphodon) dohrnii*	Brazil	do	E	15	NA	NA
Honeycreeper, crested (='akohekohe)	*Palmeria dolei*	U.S.A. (HI)	do	E	1	NA	NA
Hornbill, helmeted	*Rhinoplax vigil*	Thailand, Malaysia	do	E	15	NA	NA
Honeyeater, helmeted	*Meliphaga cassidix*	Australia	do	E	4	NA	NA
Ibis, Japanese crested	*Nipponia nippon*	China, Japan, U.S.S.R., Korea	do	E	3	NA	NA
Kagu	*Rhynochetos jubatus*	South Pacific Ocean: New Caledonia	do	E	3	NA	NA
Kakapo (=owl-parrot)	*Strigops habroptilus*	New Zealand	do	E	3	NA	NA
Kestrel, Mauritius	*Falco punctatus*	Indian Ocean: Mauritius	do	E	3	NA	NA
Kestrel, Seychelles	*Falco araea*	Indian Ocean: Seychelles Islands	do	E	3	NA	NA
Kingfisher, Guam Micronesian	*Halcyon cinnamomina cinnamomina*	Western Pacific Ocean: U.S.A. (Guam)	do	E	158	NA	NA
Kite, Cuba hook-billed	*Chondrohierax uncinatus wilsonii*	West Indies: Cuba	do	E	3	NA	NA
Kite, Everglade snail	*Rostrhamus sociabilis plumbeus*	U.S.A. (FL), Cuba	Florida	E	1	17.95(b)	NA
Kite, Grenada hook-billed	*Chondrohierax uncinatus mirus*	West Indies: Grenada	Entire	E	3	NA	NA
Kokako (wattlebird)	*Callaeas cinerea*	New Zealand	do	E	3	NA	NA
Macaw, glaucous	*Anodorhynchus glaucus*	Paraguay, Uruguay, Brazil	do	E	15	NA	NA
Macaw, indigo	*Anodorhynchus leari*	Brazil	do	E	15	NA	NA
Macaw, little blue	*Cyanopsitta spixii*	do	do	E	15	NA	NA
Magpie-robin, Seychelles (thrush)	*Copsychus sechellarum*	Indian Ocean: Seychelles Islands	do	E	3	NA	NA
Malkoha, red-faced (cuckoo)	*Phaenicophaeus pyrrhocephalus*	Sri Lanka (=Ceylon)	do	E	3	NA	NA
Mallard, Mariana	*Anas oustaleti*	West Pacific Ocean: U.S.A. (Guam, Mariana Islands).	do	E	23	NA	NA
Megapode, Micronesian (=La Perouse's)	*Megapodius laperouse*	West Pacific Ocean: U.S.A. (Palau Island, Mariana Islands).	do	E	3	NA	NA
Megapode, Maleo	*Macrocephalon maleo*	Indonesia (Celebes)	do	E	3	NA	NA
Millerbird, Nihoa (old world warbler)	*Acrocephalus familiaris kingi*	U.S.A. (HI)	do	E	1	NA	NA
Monarch, Tinian (old world flycatcher)	*Monarcha takatsukasae*	Western Pacific Ocean: U.S.A. (Mariana Islands).	do	E	3	NA	NA
Moorhen (=gallinule), Hawaiian common	*Gallinula chloropus sandvicensis*	U.S.A. (HI)	do	E	1	NA	NA
Moorhen (=gallinule), Mariana common	*Gallinula chloropus guami*	Western Pacific Ocean: U.S.A. (Guam, Tinian, Saipan, Pagan).	do	E	158	NA	NA
Nightjar (=whip-poor-will), Puerto Rico	*Caprimulgus noctitherus*	U.S.A. (PR)	do	E	6	NA	NA
Nukupu'u (honeycreeper)	*Hemignathus lucidus*	U.S.A. (HI)	do	E	1, 2	NA	NA
'O'o, Kauai (='O'o 'A'a) (honeyeater)	*Moho braccatus*	do	do	E	1	NA	NA
Ostrich, Arabian	*Struthio camelus syriacus*	Jordan, Saudi Arabia	do	E	3	NA	NA
Ostrich, West African	*Struthio camelus spatzi*	Spanish Sahara	do	E	3	NA	NA
'O'u (honeycreeper)	*Psittirostra psittacea*	U.S.A. (HI)	do	E	1	NA	NA
Owl, Anjouan scops	*Otus rutilus capnodes*	Indian Ocean: Comoro Island	do	E	3	NA	NA
Owl, giant scops	*Otus gurneyi*	Philippines: Marinduque and Mindanao Island	do	E	15	NA	NA
Owl, Seychelles	*Otus insularis*	Indian Ocean: Seychelles Islands	do	E	3	NA	NA
Owlet, Morden's (=Sokoke)	*Otus ireneae*	Kenya	do	E	3	NA	NA
Palila (honeycreeper)	*Loxioides (=Psittirostra) bailleui*	U.S.A. (HI)	do	E	1	17.95(b)	NA
Parakeet, Forbes'	*Cyanoramphus auriceps forbesi*	New Zealand	do	E	3, 15	NA	NA
Parakeet, golden	*Aratinga guarouba*	Brazil	do	E	4	NA	NA
Parakeet, golden-shouldered (=hooded)	*Psephotus chrysopterygius*	Australia	do	E	3	NA	NA
Parakeet, Mauritius	*Psittacula echo*	Indian Ocean: Mauritius	do	E	3	NA	NA

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Parakeet, ochre-marked	*Pyrrhura cruentata*	Brazil	...do	E	3	NA	NA
Parakeet, orange-bellied	*Neophema chrysogaster*	Australia	...do	E	4	NA	NA
Parakeet, paradise (= beautiful)	*Psephotus pulcherrimus*	...do	...do	E	4	NA	NA
Parakeet, scarlet-chested (= splendid)	*Neophema splendida*	...do	...do	E	4	NA	NA
Parakeet, turquoise	*Neophema pulchella*	...do	...do	E	3	NA	NA
Parrot, Australian	*Geopsittacus occidentalis*	...do	...do	E	3	NA	NA
Parrot, Bahaman or Cuban	*Amazona leucocephala*	West Indies: Cuba, Bahamas, Caymans	...do	E	3, 15	NA	NA
Parrot, ground	*Pezoporus wallicus*	Australia	...do	E	6	NA	NA
Parrot, imperial	*Amazona imperialis*	West Indies: Dominica	...do	E	3	NA	NA
Parrot, Puerto Rican	*Amazona vittata*	U.S.A. (PR)	...do	E	1	NA	NA
Parrot, red-browed	*Amazona rhodocorytha*	Brazil	...do	E	3	NA	NA
Parrot, red-capped	*Pionopsitta pileata*	...do	...do	E	15	NA	NA
Parrot, red-necked	*Amazona arausiaca*	West Indies: Dominica	...do	E	50	NA	NA
Parrot, red-spectacled	*Amazona pretrei pretrei*	Brazil, Argentina	...do	E	15	NA	NA
Parrot, St. Lucia	*Amazona versicolor*	West Indies: St. Lucia	...do	E	3	NA	NA
Parrot, St. Vincent	*Amazona guildingii*	West Indies: St. Vincent	...do	E	3	NA	NA
Parrot, thick-billed	*Rhynchopsitta pachyrhyncha*	Mexico, U.S.A. (AZ, NM)	Mexico	E	3	NA	NA
Parrot, vinaceous-breasted	*Amazona vinacea*	Brazil	Entire	E	15	NA	NA
Parrotbill, Maui (honeycreeper)	*Pseudonestor xanthophrys*	U.S.A. (HI)	...do	E	1	NA	NA
Pelican, brown	*Pelecanus occidentalis*	U.S.A (Carolinas to TX, CA), West Indies, C. and S. America: Coastal.	Entire, except U.S. Atlantic coast, FL, AL.	E	2, 3, 171	NA	NA
Penguin, Galapagos	*Spheniscus mendiculus*	Ecuador (Galapagos Islands)	Entire	E	3	NA	NA
Petrel, Hawaiian dark-rumped	*Pterodroma phaeopygia sandwichensis*	U.S.A. (HI)	...do	E	2, 4, 1	NA	NA
Pheasant, bar-tailed	*Syrmaticus humiae*	Burma, China	...do	E	3	NA	NA
Pheasant, Blyth's tragopan	*Tragopan blythii*	Burma, China, India	...do	E	3	NA	NA
Pheasant, brown eared	*Crossoptilon mantchuricum*	China	...do	E	3	NA	NA
Pheasant, Cabot's tragopan	*Tragopan caboti*	...do	...do	E	3	NA	NA
Pheasant, Chinese monal	*Lophophorus lhuysii*	...do	...do	E	3	NA	NA
Pheasant, Edward's	*Lophura edwardsi*	Vietnam	...do	E	3	NA	NA
Pheasant, Elliot's	*Syrmaticus ellioti*	China	...do	E	3	NA	NA
Pheasant, imperial	*Lophura imperialis*	Vietnam	...do	E	15	NA	NA
Pheasant, Mikado	*Syrmaticus mikado*	Taiwan	...do	E	3	NA	NA
Pheasant, Palawan peacock	*Polyplectron emphanum*	Philippines	...do	E	3	NA	NA
Pheasant, Sclater's monal	*Lophophorus sclateri*	Burma, China, India	...do	E	3	NA	NA
Pheasant, Swinhoe's	*Lophura swinhoii*	Taiwan	...do	E	3	NA	NA
Pheasant, western tragopan	*Tragopan melanocephalus*	India, Pakistan	...do	E	3	NA	NA
Pheasant, white eared	*Crossoptilon crossoptilon*	China (Tibet), India	...do	E	3	NA	NA
Pigeon, Azores wood	*Columba palumbus azorica*	East Atlantic Ocean: Azores	...do	E	4	NA	NA
Pigeon, Chatham Island	*Hemiphaga novaeseelandiae chathamensis.*	New Zealand	...do	E	3	NA	NA
Pigeon, Mindoro zone-tailed	*Ducula mindorensis*	Philippines	...do	E	15	NA	NA
Pigeon, Puerto Rican plain	*Columba inornata wetmorei*	U.S.A. (PR)	...do	E	2	NA	NA

Piping guan, black-fronted	*Pipile jacutinga*	Argentina	...do	E	15	NA	NA
Pitta, Koch's	*Pitta kochi*	Philippines	...do	E	15	NA	NA
Plover, New Zealand shore	*Thinornis novaeseelandiae*	New Zealand	...do	E	3	NA	NA
Plover, piping	*Charadrius melodus*	U.S.A. (Great Lakes, northern Great Plains, Atlantic ...	Great Lakes	E	[illegible]		

Pigeon, Mindoro zone-tailed	*Ducula mindorensis*	Philippin	do	E	15	NA	NA
Pigeon, Puerto Rican plain	*Columba inornata wetmorei*	U.S.A. (I	do	E	8	NA	NA

Piping-guan, black-fronted	*Pipile jacutinga*	Argentina	do	E	15	NA	NA
Pitta, Koch's	*Pitta kochi*	Philippines	do	E	15	NA	NA
Plover, New Zealand shore	*Thinornis novaeseelandiae*	New Zealand	do	E	3	NA	NA
Plover, piping	*Charadrius melodus*	U.S.A. (Great Lakes, northern Great Plains, Atlantic and Gulf coasts, PR VI), Canada, Mexico, Bahamas, West Indies.	Great Lakes watershed in States of IL, IN, MI, MN, NY, OH, PA, and WI and Province of Ontario.	E	211	NA	NA
Do	do	do	Entire, except those areas where listed as endangered above.	T	211	NA	NA
Po'ouli (honeycreeper)	*Melamprosops phaeosoma*	U.S.A. (HI)	Entire	E	10	NA	NA
Prairie-chicken, Attwater's greater	*Tympanuchus cupido attwateri*	U.S.A. (TX)	do	E	1	NA	NA
Quail, Merriam's Montezuma	*Cyrtonyx montezumae merriami*	Mexico (Vera Cruz)	do	E	15	NA	NA
Quetzal, resplendent	*Pharomachrus mocinno*	Mexico to Panama	do	E	15	NA	NA
Rail, Aukland Island	*Rallus pectoralis muelleri*	New Zealand	do	E	3	NA	NA
Rail, California clapper	*Rallus longirostris obsoletus*	U.S.A. (CA)	do	E	2	NA	NA
Rail, Guam	*Rallus owstoni*	Western Pacific Ocean: U.S.A. (Guam)	do	E	146E, 156	NA	NA
Rail, light-footed clapper	*Rallus longirostris levipes*	U.S.A. (CA), Mexico (Baja California)	do	E	2	NA	NA
Rail, Lord Howe wood	*Tricholimnas sylvestris*	Australia (Lord Howe Island)	do	E	15	NA	NA
Rail, Yuma clapper	*Rallus longirostris yumanensis*	Mexico, U.S.A. (AZ, CA)	do	E	1	NA	NA
Rhea, Darwin's	*Pterocnemia pennata*	Argentina, Bolivia, Peru, Uruguay	do	E	3	NA	NA
Robin, Chatham Island	*Petroica traversi*	New Zealand	do	E	3	NA	NA
Robin, scarlet-breasted (flycatcher)	*Petroica multicolor multicolor*	Australia (Norfolk Island)	do	E	3	NA	NA
Rockfowl, grey-necked	*Picathartes oreas*	Cameroon, Gabon	do	E	3	NA	NA
Rockfowl, white-necked	*Picathartes gymnocephalus*	Africa: Togo to Sierra Leone	do	E	3	NA	NA
Roller, long-tailed ground	*Uratelornis chimaera*	Malagasy Republic (=Madagascar)	do	E	3	NA	NA
Scrub-bird, noisy	*Atrichornis clamosus*	Australia	do	E	3	NA	NA
Shama, Cebu black (thrush)	*Copsychus niger cebuensis*	Philippines	do	E	3	NA	NA
Shearwater, Newell's Townsend's (formerly Manx) (='A'o).	*Puffinus auricularis* (formerly *puffinus*) *newelli*.	U.S.A. (HI)	do	T	10	NA	NA
Shrike, San Clemente loggerhead	*Lanius ludovicianus mearnsi*	U.S.A. (CA)	do	E	28	NA	NA
Siskin, red	*Carduelis* (=*Spinus*) *cucullata*	South America	do	E	15	NA	NA
Sparrow, Cape Sable seaside	*Ammodramus* (=*Ammospiza*) *maritimus mirabilis*.	U.S.A. (FL)	do	E	1	17.95(b)	NA
Sparrow, dusky seaside	*Ammodramus* (=*Ammospiza*) *maritimus nigrescens*.	do	do	E	1	17.95(b)	NA
Sparrow, Florida grasshopper	*Ammodramus savannarum floridanus*	do	do	E	238	NA	NA
Sparrow, San Clemente sage	*Amphispiza belli clementeae*	U.S.A. (CA)	do	T	28	NA	NA
Starling, Ponape mountain	*Aplonis pelzelni*	West Pacific Ocean: U.S.A. (Caroline Islands).	do	E	3	NA	NA
Starling, Rothschild's (myna)	*Leucopsar rothschildi*	Indonesia (Bali)	do	E	3	NA	NA

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Stilt, Hawaiian (=Ae'o)	*Himantopus mexicanus (=himantopus) knudseni.*	U.S.A. (Hawaii)	...do	E	2	NA	NA
Stork, oriental white	*Ciconia ciconia boyciana*	China, Japan, Korea, U.S.S.R.	...do	E	3	NA	NA
Stork, wood	*Mycteria americana*	U.S.A. (CA, AZ, TX, to Carolinas), Mexico, Central and South America.	U.S.A. (AL, FL, GA, SC).	E	142	NA	NA
Swiftlet, Mariana gray (=Vanikoro)	*Aerodramus (=Collocalia) vanikorensis bartschi.*	Western Pacific Ocean: U.S.A. (Guam, Rota, Tinian, Saipan, Agiguan).	Entire	E	156	NA	NA
Teal, Campbell Island flightless	*Anas aucklandica nesiotis*	New Zealand (Campbell Island)	...do	E	15	NA	NA
Tern, California least	*Sterna antillarum (=albifrons) browni*	Mexico, U.S.A. (CA)	...do	E	2, 3	NA	NA
Tern, least	*Sterna antillarum*	U.S.A. (Atlantic and Gulf coasts, Miss. R. Basin, CA), Gr. and Lesser Antilles, Bahamas, Mexico; winters C. America, northern S. America.	U.S.A. [AR, CO, IA, IL, IN, KS, KY, LA (Miss. R. and tribs. N of Baton Rouge), MS (Miss. R.), MO, MT, NE, NM, ND, OK, SD, TN, TX (Except within 50 miles of coast)].	E	182	NA	NA
Thrasher, white-breasted	*Ramphocinclus brachyurus*	West Indies: St. Lucia, Martinique	Entire	E	3	NA	NA
Thrush, large Kauai	*Myadestes (=Phaeornis) myadestinus*	U.S.A. (HI)	...do	E	2	NA	NA
Thrush, Molokai (=oloma'o)	*Myadestes (=Phaeornis) lanaiensis (=obscurus) rutha.*	...do	...do	E	2	NA	NA
Thrush, New Zealand (wattlebird)	*Turnagra capensis*	New Zealand	...do	E	3	NA	NA
Thrush, small Kauai (=puaiohi)	*Myadestes (=Phaeornis) palmeri*	U.S.A. (HI)	...do	E	1	NA	NA
Tinamou, solitary	*Tinamus solitarius*	Brazil, Paraguay, Argentina	...do	E	15	NA	NA
Trembler, Martinique (thrasher)	*Cinclocerthia ruficauda gutturalis*	West Indies: Martinique	...do	E	3	NA	NA
Vireo, least Bell's	*Vireo bellii pusillus*	U.S.A. (CA), Mexico	...do	E	228	NA	NA
Wanderer, plain (collared-hemipode)	*Pedionomous torquatus*	Australia	...do	E	6	NA	NA
Warbler (wood), Bachman's	*Vermivora bachmanii*	U.S.A. (Southeastern), Cuba	...do	E	1, 3	NA	NA
Warbler (wood), Barbados yellow	*Dendroica petechia petechia*	West Indies: Barbados	...do	E	3	NA	NA
Warbler (wood), Kirtland's	*Dendroica kirtlandii*	U.S.A. (principally MI), Canada, West Indies: Bahama Islands.	...do	E	1, 3	NA	NA
Warbler (willow), nightingale reed	*Acrocephalus luscinia*	Western Pacific Ocean	U.S.A. (Mariana Islands).	E	3, 4	NA	NA
Warbler (willow), Rodrigues	*Bebrornis rodericanus*	Mauritius (Rodrigues Islands)	Entire	E	3	NA	NA
Warbler (wood), Semper's	*Leucopeza semperi*	West Indies: St. Lucia	...do	E	3	NA	NA
Warbler (willow), Seychelles	*Bebrornis sechellensis*	Indian Ocean: Seychelles Island	...do	E	3	NA	NA
Whipbird, Western	*Psophodes nigrogularis*	Australia	...do	E	3	NA	NA
White-eye, bridled	*Zosterops conspicillata conspicillata*	Western Pacific Ocean: U.S.A. (Guam)	...do	E	156	NA	NA
White-eye, Norfolk Island	*Zosterops albogularis*	Indian Ocean: Norfolk Islands	...do	E	15	NA	NA
White-eye, Ponape greater	*Rukia longirostra (=sanfordi)*	West Pacific Ocean: U.S.A. (Caroline Islands).	...do	E	3	NA	NA

White-eye, Seychelles	*Zosterops modesta*	Indian Ocean: Seychelles	...do	E	3	NA	NA
Woodpecker, imperial	*Campephilus imperialis*	Mexico	...do	E	3	NA	NA
Woodpecker, ivory-billed	*Campephilus principalis*	U.S.A. (southcentral and southeastern), Cuba.	...do	E	1, 3	NA	NA
Woodpecker, red cockaded	*Picoides (=Dendrocopos) borealis*	U.S.A. (southcentral and southeastern)	...do	E	2	NA	NA
Woodpecker, Tristam's	*Dryocopus javensis richardsi*	Korea	...do	E	3	NA	NA
Wren, Guadeloupe house	*Troglodytes aedon guadeloupensis*	West Indies: Guadeloupe	...do	E	3	NA	NA
Wren, St. Lucia house	*Troglodytes aedon mesoleucus*	West Indies: St. Lucia	...do	E	3	NA	NA

REPTILES

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White-eye, Seychelles	*Zosterops modesta*	Indian Ocean: Seychelles	do	E	3	NA	NA
Woodpecker, imperial	*Campephilus imperialis*	Mexico	do	E	3	NA	NA
Woodpecker, ivory-billed	*Campephilus principalis*	U.S.A. (southcentral and southeastern), Cuba.	do	E	1, 3	NA	NA
Woodpecker, red-cockaded	*Picoides (= Dendrocopos) borealis*	U.S.A. (southcentral and southeastern)	do	E	2	NA	NA
Woodpecker, Tristam's	*Dryocopus javensis richardsi*	Korea	do	E	3	NA	NA
Wren, Guadeloupe house	*Troglodytes aedon guadeloupensis*	West Indies: Guadeloupe	do	E	3	NA	NA
Wren, St. Lucia house	*Troglodytes aedon mesoleucus*	West Indies: St. Lucia	do	E	3	NA	NA
REPTILES							
Alligator, American	*Alligator mississippiensis*	Southeastern U.S.A.	Wherever found in wild except those areas where listed as threatened as set forth below.	E	1, 11, 51, 60, 113, 134, 186	NA	NA
Do	do	do	U.S.A. (certain areas of GA and SC, as set forth in 17.42(a)(1)).	T	20, 47, 51, 60, 134, 186	NA	17.42(a)
Do	do	do	17.42(a)(1)). U.S.A. (FL, LA and TX); in captivity wherever found.	T(S/A)	11, 47, 51, 60, 113, 134, 186	NA	17.42(a)
Alligator, Chinese	*Alligator sinensis*	China	Entire	E	15	NA	NA
Anole, Culebra Island giant	*Anolis roosevelti*	U.S.A. (PR: Culebra Island)	do	E	25	17.95(c)	NA
Boa, Jamaican	*Epicrates subflavus*	Jamaica	do	E	3	NA	NA
Boa, Mona	*Epicrates monensis monensis*	U.S.A. (PR)	do	T	33	17.95(c)	NA
Boa, Puerto Rico	*Epicrates inornatus*	do	do	E	2	NA	NA
Boa, Round Island [no common name]	*Casarea dussumieri*	Indian Ocean: Mauritius	do	E	88	NA	NA
Boa, Round Island [no common name]	*Bolyeria multocarinata*	do	do	E	88	NA	NA
Boa, Virgin Islands tree	*Epicrates monensis granti*	U.S. and British Virgin Islands	do	E	2, 88	NA	NA
Caiman, Apaporis River	*Caiman crocodilus apaporiensis*	Colombia	do	E	15	NA	NA
Caiman, black	*Melanosuchus niger*	Amazon basin	do	E	15	NA	NA
Caiman, broad-snouted	*Caiman latirostris*	Brazil, Argentina, Paraguay, Uruguay	do	E	15	NA	NA
Caiman, Yacare	*Caiman crocodilus yacare*	Bolivia, Argentina, Peru, Brazil	do	E	3	NA	NA
Chuckwalla, San Esteban Island	*Sauromalus varius*	Mexico	do	E	88	NA	NA
Crocodile, African dwarf	*Osteolaemus tetraspis tetraspis*	West Africa	do	E	15	NA	NA
Crocodile, African slender-snouted	*Crocodylus cataphractus*	Western and central Africa	do	E	5	NA	NA
Crocodile, American	*Crocodylus acutus*	U.S.A. (FL), Mexico, South America, Central America, Caribbean.	do	E	10, 87	17.95(c)	NA
Crocodile, Ceylon mugger	*Crocodylus palustris kimbula*	Sri Lanka	do	E	15	NA	NA
Crocodile, Congo dwarf	*Osteolaemus tetraspis osborni*	Congo River drainage	do	E	15	NA	NA
Crocodile, Cuban	*Crocodylus rhombifer*	Cuba	do	E	3	NA	NA
Crocodile, Morelet's	*Crocodylus moreletii*	Mexico, Belize, Guatemala	do	E	3	NA	NA
Crocodile, mugger	*Crocodylus palustris palustris*	India, Pakistan, Iran, Bangladesh	do	E	15	NA	NA
Crocodile, Nile	*Crocodylus niloticus*	Africa	do	E	3	NA	NA

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Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
Crocodile, Orinoco	*Crocodylus intermedius*	South America: Orinoco River Basin	do	E	3	NA	NA
Crocodile, Philippine	*Crocodylus novaeguineae mindorensis*	Philippine Islands	do	E	15	NA	NA
Crocodile, saltwater (= estuarine)	*Crocodylus porosus*	Southeast Asia, Australia, Papua-New Guinea, Pacific Islands.	Entire, except Papua-New Guinea.	E	87	NA	NA
Crocodile, Siamese	*Crocodylus siamensis*	Southeast Asia, Malay Peninsula	Entire	E	15	NA	NA
Gavial (= gharial)	*Gavialis gangeticus*	Pakistan, Burma, Bangladesh, India, Nepal.	do	E	3, 15	NA	NA
Gecko, day	*Phelsuma edwardnewtoni*	Indian Ocean: Mauritius	do	E	3	NA	NA
Gecko, Monito	*Sphaerodactylus micropithecus*	U.S.A. (PR)	do	E	125	17.95(c)	NA
Gecko, Round Island day	*Phelsuma guentheri*	Indian Ocean: Mauritius	do	E	3	NA	NA
Gecko, Serpent Island	*Cyrtodactylus serpensinsula*	do	do	T	129	NA	NA
Iguana, Acklins ground	*Cyclura rileyi nuchalis*	West Indies: Bahamas	do	T	129	NA	NA
Iguana, Allen's Cay	*Cyclura cychlura inornata*	do	do	T	129	NA	NA
Iguana, Andros Island ground	*Cyclura cychlura cychlura*	do	do	T	129	NA	NA
Iguana, Anegada ground	*Cyclura pinguis*	West Indies: British Virgin Islands (Anegada Island).	do	E	3	NA	NA
Iguana, Barrington land	*Conolophus pallidus*	Ecuador (Galapagos Islands)	do	E	3	NA	NA
Iguana, Cayman Brac ground	*Cyclura nubila caymanensis*	West Indies: Cayman Islands	do	T	129	NA	NA
Iguana, Cuban ground	*Cyclura nubila nubila*	Cuba	Entire (excluding population introduced in Puerto Rico).	T	129	NA	NA
Iguana, Exuma Island	*Cyclura cychlura figginsi*	West Indies: Bahamas	Entire	T	129	NA	NA
Iguana, Fiji banded	*Brachylophus fasciatus*	Pacific: Fiji, Tonga	do	E	88	NA	NA
Iguana, Fiji crested	*Brachylophus vitiensis*	Pacific: Fiji	do	E	88	NA	NA
Iguana, Grand Cayman ground	*Cyclura nubila lewisi*	West Indies: Cayman Islands	do	E	129	NA	NA
Iguana, Jamaican	*Cyclura collei*	West Indies: Jamaica	do	E	129	NA	NA
Iguana, Mayaguana	*Cyclura carinata bartschi*	West Indies: Bahamas	do	T	129	NA	NA
Iguana, Mona ground	*Cyclura stejnegeri*	U.S.A. (PR: Mona Island)	do	T	33	17.95(c)	NA
Iguana, Turks and Caicos	*Cyclura carinata carinata*	West Indies: Turks and Caicos Islands	do	T	129	NA	NA
Iguana, Watling Island ground	*Cyclura rileyi rileyi*	West Indies: Bahamas	do	E	129	NA	NA
Iguana, White Cay ground	*Cyclura rileyi cristata*	do	do	T	129	NA	NA
Lizard, blunt-nosed leopard	*Gambelia (= Crotaphytus) silus*	U.S.A. (CA)	do	E	1	NA	NA
Lizard, Coachella Valley fringe-toed	*Uma inornata*	do	do	T	105	17.95(c)	NA
Lizard, Hierro giant	*Gallotia simonyi simonyi*	Spain (Canary Islands)	do	E	144	NA	NA
Lizard, Ibiza wall	*Podarcis pityusensis*	Spain (Balearic Islands)	do	T	144	NA	NA
Lizard, Island night	*Xantusia (= Klauberina) riversiana*	U.S.A. (CA)	do	T	26	NA	NA
Lizard, St Croix ground	*Ameiva polops*	U.S.A. (VI)	do	E	84	17.95(c)	NA
Monitor, Bengal	*Varanus bengalensis*	Iran, Iraq, India, Sri Lanka, Malaysia, Afghanistan, Burma, Vietnam, Thailand.	do	E	15	NA	NA

Monitor, desert	*Varanus griseus*	North Africa to Neareast, Caspian Sea through U.S.S.R. to Pakistan, Northwest India	do	E	15	NA	NA

Monitor, desert	*Varanus griseus*	North Africa to Nearest, Caspian Sea through U.S.S.R. to Pakistan, Northwest India.	...do	E	15	NA	NA
Monitor, Komodo Island	*Varanus komodoensis*	Indonesia (Komodo, Rintja, Padar, and western Flores Island).	...do	E	15	NA	NA
Monitor, yellow	*Varanus flavescens*	West Pakistan through India to Bangladesh.	...do	E	15	NA	NA
Python, Indian	*Python molurus molurus*	Sri Lanka and India	...do	E	15	NA	NA
Rattlesnake, Aruba Island	*Crotalus unicolor*	Aruba Island (Netherland Antilles)	...do	T	120	NA	NA
Rattlesnake, New Mexican ridge-nosed	*Crotalus willardi obscurus*	U.S.A. (NM), Mexico	...do	T	43	17.95(c)	NA
Skink, Round Island	*Leiolopisma telfairi*	Indian Ocean: Mauritius	...do	T	120	NA	NA
Snake, Atlantic salt marsh	*Nerodia fasciata taeniata*	U.S.A. (FL)	...do	T	30	NA	NA
Snake, Concho water	*Nerodia harteri paucimaculata*	U.S.A. (TX)	...do	T	241	NA	NA
Snake, eastern indigo	*Drymarchon corais couperi*	U.S.A. (AL, FL, GA, MS, SC)	...do	T	32	NA	NA
Snake, San Francisco garter	*Thamnophis sirtalis tetrataenia*	U.S.A. (CA)	...do	E	1	NA	NA
Tartaruga	*Podocnemis expansa*	South America: Orinoco and Amazon River basins.	...do	E	3	NA	NA
Terrapin, river (=Tuntong)	*Batagur baska*	Malaysia, Bangladesh, Burma, India, Indonesia.	...do	E	3	NA	NA
Tomistoma	*Tomistoma schlegelii*	Malaysia, Indonesia	...do	E	15	NA	NA
Tortoise, angulated	*Geochelone yniphora*	Malagasy Republic (=Madagascar)	...do	E	15	NA	NA
Tortoise, Bolson	*Gopherus flavomarginatus*	Mexico	...do	E	48	NA	NA
Tortoise, desert	*Xerobates (=Scaptochelys, =Gopherus) agassizii.*	U.S.A. (UT, AZ, CA, NV); Mexico	Beaver Dam Slope, Utah.	T	103	17.95(c)	NA
Tortoise, Galapagos	*Geochelone elephantopus*	Ecuador (Galapagos Islands)	Entire	E	3	NA	NA
Tortoise, radiated	*Geochelone (=Testudo) radiata*	Malagasy Republic (=Madagascar)	...do	E	3	NA	NA
Tracaja	*Podocnemis unifilis*	South America: Orinoco and Amazon River basins.	...do	E	3	NA	NA
Tuatara	*Sphenodon punctatus*	New Zealand	...do	E	3	NA	NA
Turtle, aquatic box	*Terrapene coahuila*	Mexico	...do	E	6	NA	NA
Turtle, black softshell	*Trionyx nigricans*	Bangladesh	...do	E	15	NA	NA
Turtle, Burmese peacock	*Morenia ocellata*	Burma	...do	E	15	NA	NA
Turtle, Central American river	*Dermatemys mawii*	Mexico, Belize, Guatemala	...do	E	120	NA	NA
Turtle, Cuatro Cienegas softshell	*Trionyx ater*	Mexico	...do	E	15	NA	NA
Turtle, geometric	*Psammobates geometricus (=Geochelone geometrica).*	South Africa	...do	E	15	NA	NA
Turtle, green sea	*Chelonia mydas*	Circumglobal in tropical and temperate seas and oceans.	Wherever found except where listed as endangered below.	T	2, 42	NA	17.42(b) and Parts 220 and 227.
Do	...do	...do	Breeding colony populations in FL and on Pacific coast of Mexico.	E	2, 42	NA	NA
Turtle, hawksbill sea (=carey)	*Eretmochelys imbricata*	Tropical seas	Entire	E	3	17.95(c)	NA
Turtle, Indian sawback	*Kachuga tecta tecta*	India	...do	E	15	NA	NA
Turtle, Indian softshell	*Trionyx gangeticus*	Pakistan, India	...do	E	15	NA	NA

REFERENCE 15

Environmental Sample Analysis Result Report,

21 Dec 82 to 15 Mar 83 (database printout)

ENVIRONMENTAL SAMPLE ANALYSIS RESULT REPORT

21 DEC 82 to 15 MAR 83

WATER RIVER WATER CUMULATIVE UNFILTERED

Samp #: 1265 PRIEST RAPIDS-RIVER

104/U

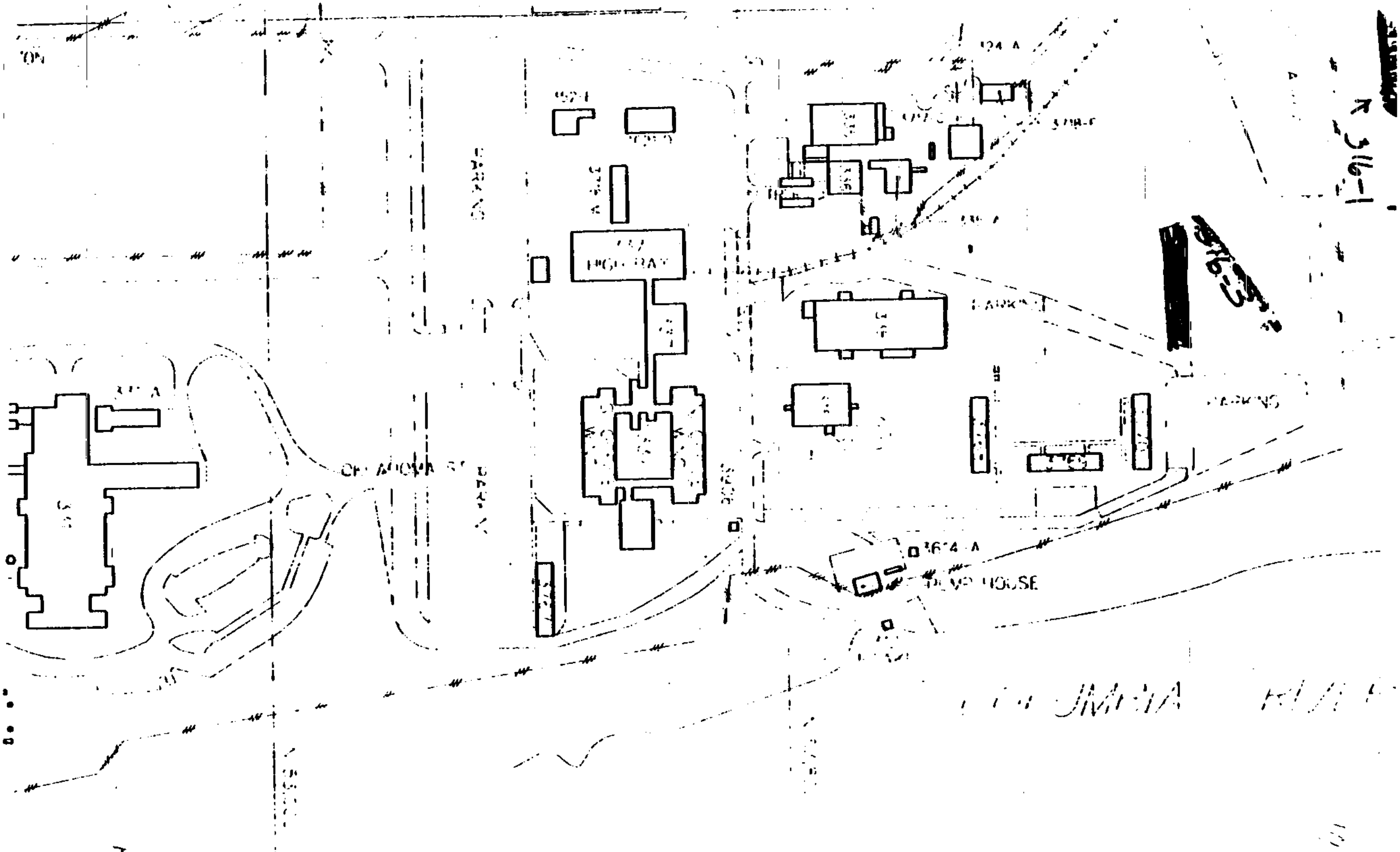
Date Off	Date On	Result +/- 2 Sigma (PCI/L)	Comments
~~21 DEC 82~~	~~23 NOV 82~~	~~2.71E-01 +/- 9.49E-02~~	(BKG)
18 JAN 83	21 DEC 82	3.27E-01 +/- 1.14E-01	
15 FEB 83	18 JAN 83	3.21E-01 +/- 1.12E-01	
15 MAR 83	15 FEB 83	4.37E-01 +/- 1.53E-01	

Fraction of Results>DL: 4/ 4 Mean: 3.39E-01
Minimum: 2.71E-01 (21 DEC 82) Standard Error of Mean: 1.01E-01
Maximum: 4.37E-01 (15 MAR 83) Standard Deviation: 2.01E-01
Median: 3.21E-01

REFERENCE 16

Drawing H-3-53734 (showing 300 Area River Intake)

9413218.0838



H-3-57234

Ref. 16.1

BEST AVAILABLE COPY

REFERENCE 17

Memo to file from WS Weygandt regarding Personal Conversation with Frank Trent concerning TUC Irrigation Intake, August 12, 1987; including note to file from RD Stenner on October 29, 1987, concerning Crops Grown on the TUC 160 Acres

Battelle
Pacific Northwest Laboratories

Project Number

Internal Distribution

File/LB

Date August 12, 1987

To File

From W. S. Weygandt

Subject Tri-Cities University Center Water Intake

A telephone conversation with Frank Trent, the ground's manager at TUC, revealed that TUC draws water from the Columbia River to irrigate approximately 160 acres. The intake is located directly behind the Center, which is located on Sprout Road.

WSW:cs

need a statement "used for forage crops" for

also need this statement for 200 Area Package

Ref. 17.1

File Note

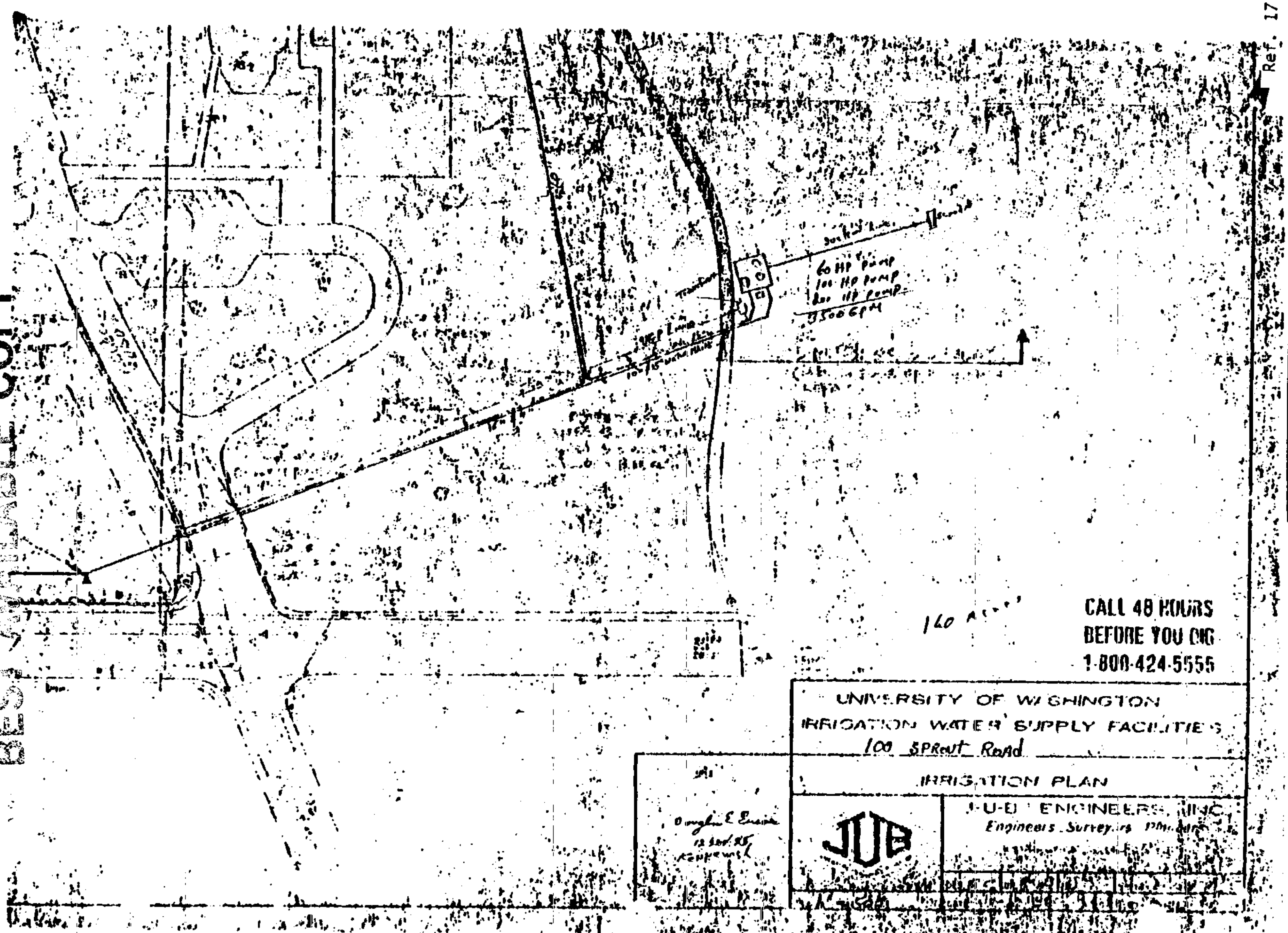
Date: 10/29/87

From: RD Stenner RD Stenner

Subject: Crops Grown on the TUC 160 Acres

The 160 Acres that are irrigated by the Tri-Cities University Center are used to grow alfalfa which is used as cattle feed.

Ref. 17.2


60 HP Pump
100 HP Pump
100 HP Pump
3500 GPM
140 Acres
CALL 48 HOURS
BEFORE YOU DIG
1-800-424-5555
UNIVERSITY OF WASHINGTON
IRRIGATION WATER SUPPLY FACILITIES
100 SPRout Road
IRRIGATION PLAN
J-U-B ENGINEERS, INC.
Engineers . Surveyors . Planners
JUB

REFERENCE 18

Endangered and Threatened Wildlife and Plants,

50 CFR, Part 17, Subpart B, October 86

issued under Part 21 of this chapter; and

(2) Identified in the earliest applicable annual report required to be filed by a permittee under Part 21 of this chapter as in a permittee's possession on November 10, 1978, or as the progeny of such a raptor.

(b) This section does not apply to any raptor intentionally returned to the wild.

[48 FR 31607, July 8, 1983]

Subpart B—Lists

SOURCE: 48 FR 34182, July 27, 1983, unless otherwise noted.

§ 17.11 Endangered and threatened wildlife.

(a) The list in this section contains the names of all species of wildlife which have been determined by the Services to be Endangered or Threatened. It also contains the names of species of wildlife treated as Endangered or Threatened because they are sufficiently similar in appearance to Endangered or Threatened species (see § 17.50 *et seq.*).

(b) The columns entitled "Common Name," "Scientific Name," and "Vertebrate Population Where Endangered or Threatened" define the species of wildlife within the meaning of the Act. Thus, differently classified geographic populations of the same vertebrate subspecies or species shall be identified by their differing geographic boundaries, even though the other two columns are identical. The term "Entire" means that all populations throughout the present range of a vertebrate species are listed. Although common names are included, they cannot be relied upon for identification of any specimen, since they may vary greatly in local usage. The Services shall use the most recently accepted scientific name. In cases in which confusion might arise, a synonym(s) will be provided in parentheses. The Services shall rely to the extent practicable on the *International Code of Zoological Nomenclature.*

(c) In the "Status" column the following symbols are used: "E" for Endangered, "T" for Threatened, and "E [or T] (S/A)" for similarity of appearance species.

(d) The other data in the list are nonregulatory in nature and are provided for the information of the reader. In the annual revision and compilation of this title, the following information may be amended without public notice: the spelling of species' names, historical range, footnotes, references to certain other applicable portions of this title, synonyms, and more current names. In any of these revised entries, neither the species, as defined in paragraph (b) of this section, nor its status may be changed without following the procedures of Part 424 of this title.

(e) The "historic range" indicates the known general distribution of the species or subspecies as reported in the current scientific literature. The present distribution may be greatly reduced from this historic range. This column does not imply any limitation on the application of the prohibitions in the Act or implementing rules. Such prohibitions apply to all individuals of the species, wherever found.

(f)(1) A footnote to the FEDERAL REGISTER publication(s) listing or reclassifying a species is indicated under the column "When listed." Footnote numbers to §§ 17.11 and 17.12 are in the same numerical sequence, since plants and animals may be listed in the same FEDERAL REGISTER document. That document, at least since 1973, includes a statement indicating the basis for the listing, as well as the effective date(s) of said listing.

(2) The "Special rules" and "Critical habitat" columns provide a cross reference to other sections in Parts 17, 222, 226, or 227. The "Special rules" column will also be used to cite the special rules that describe experimental populations and determine if they are essential or nonessential. Separate listing will be made for experimental populations, and the status column will include the following symbols: "XE" for an essential experimental population and "XN" for a nonessential experimental population. The term "NA" (not applicable) appearing in either of these two columns indicates that there are no special rules and/or critical habitat for that par-

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other rules
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references
column list
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species or t
Federal age
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ticular species. However, all other appropriate rules in Parts 17, 217 through 227, and 402 still apply to that species. In addition, there may be other rules in this title that relate to such wildlife, e.g., port-of-entry requirements. It is not intended that the references in the "Special rules" column list all the regulations of the two Services which might apply to the species or to the regulations of other Federal agencies or State or local governments.

(g) The listing of a particular taxon includes all lower taxonomic units. For example, the genus *Hylobates* (gibbons) is listed as Endangered throughout its entire range (China, India, and SE Asia); consequently, all species, subspecies, and populations of that genus are considered listed as Endangered for the purposes of the Act. In 1978 (43 FR 6230-6233) the species *Haliaeetus leucocephalus* (bald eagle) was listed as Threatened in "USA (WA, OR, MN, WI, MI)" rather than its entire population; thus, all individuals of the bald eagle found in those five States are considered listed as Threatened for the purposes of the Act.

(h) The "List of Endangered and Threatened Wildlife" is provided below:

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
MAMMALS							
Anoa, lowland	*Bubalus depressicornis* (=*B. anoa depressicornis*).	Indonesia	Entire	E	3	NA	NA
Anoa, mountain	*Bubalus quarlesi* (=*B. anoa quarlesi*)	...do	...do	E	15	NA	NA
Antelope, giant sable	*Hippotragus niger variani*	Angola	...do	E	15	NA	NA
Argali	*Ovis ammon hodgsoni*	China (Tibet, Himalayas)	...do	E	15	NA	NA
Armadillo, giant	*Priodontes maximus* (=*giganteus*)	Venezuela and Guyana to Argentina	...do	E	15	NA	NA
Armadillo, pink fairy	*Chlamyphorus truncatus*	Argentina	...do	E	3	NA	NA
Ass, African wild	*Equus asinus* (=*africanus*)	Somalia, Sudan, Ethiopia	Somalia, Sudan, Ethiopia.	E	3, 22	NA	NA
Ass, Asian wild (=kulan, onager)	*Equus hemionus*	Southwestern and Central Asia	Entire	E	3	NA	NA
Avahi	*Avahi* (=*Lichanotus*) *laniger* (=entire genus).	Malagasy Republic (=Madagascar)	...do	E	3	NA	NA
Aye-Aye	*Daubentonia madagascariensis*	Malagasy Republic (=Madagascar)	...do	E	3	NA	NA
Babirusa	*Babyrousa babyrussa*	Indonesia	...do	E	15	NA	NA
Baboon, gelada	*Theropithecus gelada*	Ethiopia	...do	T	15	NA	17.40(c)
Bandicoot, barred	*Perameles bougainville*	Australia	...do	E	4	NA	NA
Bandicoot, desert	*Perameles eremiana*	...do	...do	E	6	NA	NA
Bandicoot, lesser rabbit	*Macrotis leucura*	...do	...do	E	4	NA	NA
Bandicoot, pig-footed	*Chaeropus ecaudatus*	...do	...do	E	4	NA	NA
Bandicoot, rabbit	*Macrotis lagotis*	...do	...do	E	4	NA	NA
Banteng	*Bos javanicus* (=*banteng*)	Southeast Asia	...do	E	3	NA	NA
Bat, Bulmer's fruit (flying fox)	*Aproteles bulmerae*	Papua New Guinea	...do	E	139	NA	NA
Bat, bumblebee	*Craseonycteris thonglongyai*	Thailand	...do	E	139	NA	NA
Bat, gray	*Myotis grisescens*	Central and Southeastern U.S.A.	...do	E	13	NA	NA
Bat, Hawaiian hoary	*Lasiurus cinereus semotus*	U.S.A. (HI)	...do	E	2	NA	NA
Bat, Indiana	*Myotis sodalis*	Eastern and Midwestern U.S.A.	...do	E	1	17.95(a)	NA
Bat, little Mariana fruit	*Pteropus tokudae*	Western Pacific Ocean: U.S.A. (Guam)	...do	E	156	NA	NA
Bat, Mariana fruit	*Pteropus mariannus mariannus*	Western Pacific Ocean: U.S.A. (Guam, Rota, Tinian, Saipan, Agiguan).	Guam	E	156	NA	NA
Bat, Ozark big-eared	*Plecotus townsendii ingens*	U.S.A. (MO, OK, AR)	Entire	E	85	NA	NA
Bat, Rodrigues fruit (flying fox)	*Pteropus rodricensis*	Indian Ocean: Rodrigues Island	...do	E	139	NA	NA
Bat, Singapore roundleaf horseshoe	*Hipposideros ridleyi*	Malaysia	...do	E	139	NA	NA
Bat, Virginia big-eared	*Plecotus townsendii virginianus*	U.S.A. (KY, NC, WV, VA)	...do	E	85	17.95(a)	NA
Bear, Baluchistan	*Ursus thibetanus gedrosianus*	Iran, Pakistan	...do	E	233	NA	NA
Bear, brown	*Ursus arctos pruinosus*	China (Tibet)	...do	E	15	NA	NA
			Guam				
Bear, brown	*Ursus arctos arctos*	Palearctic	Italy	E	15	NA	NA
Bear, brown or grizzly	*Ursus arctos* (=*U.a. horribilis*)	Holarctic	U.S.A. 48 conterminous States.	T	1, 2, 9	[illegible]	[illegible]
Bear, brown or grizzly	*Ursus arctos* (=*U.a. nelsoni*)	Holarctic	Mexico	E	3	NA	NA
Beaver	*Castor fiber birulai*	Mongolia	Entire	E	15	NA	NA
Bison, wood	*Bison bison athabascae*	Canada, Northwestern U.S.A.	Canada	E	3	NA	NA

Bobcat	*Felis rufus escuinapae*	Central Mexico	Entire	E	15	NA	NA
Bontebok (antelope)	*Damaliscus dorcas dorcas*	South Africa	...do	E	15	NA	NA
Camel, Bactrian	*Camelus bactrianus* (=*ferus*)	Mongolia, China	...do	E	15	NA	NA
Caribou, woodland	*Rangifer tarandus caribou*	Canada, U.S.A. (AK, ID, ME, MI, MN, MT, NH, VT, WA, WI).	Canada (that part of S.E. Brit. Col. bounded by the Can.-USA border,	E	128E, 136E, 143	NA	NA

Bobcat	*Felis rufus escuinapae*	Central Mexico	Entire	E	15	NA	NA
Bontebok (antelope)	*Damaliscus dorcas dorcas*	South Africa	do	E	15	NA	NA
Camel, Bactrian	*Camelus bactrianus* (=*ferus*)	Mongolia, China	do	E	15	NA	NA
Caribou, woodland	*Rangifer tarandus caribou*	Canada, U.S.A. (AK, ID, ME, MI, MN, MT, NH, VT, WA, WI).	Canada (that part of S.E. Brit. Col. bounded by the Can.-USA border, Columbia R., Kootenay R., Kootenay L., and Kootenai R.), U.S.A. (ID, WA).	E	128E, 136E, 143	NA	NA
Cat, Andean	*Felis jacobita*	Chile, Peru, Bolivia, Argentina	Entire	E	15	NA	NA
Cat, black-footed	*Felis nigripes*	Southern Africa	do	E	15	NA	NA
Cat, flat-headed	*Felis planiceps*	Malaysia, Indonesia	do	E	15	NA	NA
Cat, Iriomote	*Felis (Mayailurus) iriomotensis*	Japan (Iriomote Island, Ryukyu Islands)	do	E	50	NA	NA
Cat, leopard	*Felis bengalensis bengalensis*	India, Southeast Asia	do	E	15	NA	NA
Cat, marbled	*Felis marmorata*	Nepal, Southeast Asia, Indonesia	do	E	15	NA	NA
Cat, Pakistan sand	*Felis margarita scheffeli*	Pakistan	do	E	139	NA	NA
Cat, Temminck's (=golden cat)	*Felis temmincki*	Nepal, China, Southeast Asia, Indonesia (Sumatra).	do	E	15	NA	NA
Cat, tiger	*Felis tigrinus*	Costa Rica to northern Argentina	do	E	5	NA	NA
Chamois, Apennine	*Rupicapra rupicapra ornata*	Italy	do	E	15	NA	NA
Cheetah	*Acinonyx jubatus*	Africa to India	do	E	3, 5	NA	NA
Chimpanzee	*Pan troglodytes*	West and Central Africa	do	T	16	NA	17.40(c)
Chimpanzee, pygmy	*Pan paniscus*	Zaire	do	T	16	NA	17.40(c)
Chinchilla	*Chinchilla brevicaudata boliviana*	Bolivia	do	E	15	NA	NA
Civet, Malabar large-spotted	*Viverra megaspila civettina*	India	do	E	50	NA	NA
Cochito (=Gulf of California harbor porpoise).	*Phocoena sinus*	Mexico (Gulf of California)	do	E	169	NA	NA
Colobus, Preuss's red	*Colobus badius preussi*	Cameroon	do	E	138	NA	NA
Cougar, eastern	*Felis concolor couguar*	Eastern North America	do	E	6	NA	NA
Deer, Bactrian	*Cervus elaphus bactrianus*	U.S.S.R., Afghanistan	do	E	50	NA	NA
Deer, Bawean	*Axis* (=*Cervus*) *porcinus kuhli*	Indonesia	do	E	3	NA	NA
Deer, Barbary	*Cervus elaphus barbarus*	Morocco, Tunisia, Algeria	do	E	50	NA	NA
Deer, Cedros Island mule	*Odocoileus hemionus cedrosensis*	Mexico (Cedros Island)	do	E	10	NA	NA
Deer, Columbian white-tailed	*Odocoileus virginianus leucurus*	U.S.A. (WA, OR)	do	E	1	NA	NA
Deer, Corsican red	*Cervus elaphus corsicanus*	Corsica, Sardinia	do	E	50	NA	NA
Deer, Eld's brow-antlered	*Cervus eldi*	India to Southeast Asia	do	E	3	NA	NA
Deer, Formosan sika	*Cervus nippon taiouanus*	Taiwan	do	E	50	NA	NA
Deer, hog	*Axis* (=*Cervus*) *porcinus annamiticus*	Thailand, Indochina	do	E	15	NA	NA
Deer, key	*Odocoileus virginianus clavium*	U.S.A. (FL)	do	E	1	NA	NA
Deer, marsh	*Blastocerus dichotomus*	Argentina, Uruguay, Paraguay, Bolivia, Brazil.	do	E	3	NA	NA
Deer, McNeill's	*Cervus elaphus macneilli*	China (Sinkiang, Tibet)	do	E	3	NA	NA

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Deer, musk	*Moschus* spp. (all species)	Central and East Asia	Afghanistan, Bhutan, Burma, China (Tibet, Yunnan), India, Nepal, Pakistan, Sikkim.	E	15	NA	NA
Deer, North China sika	*Cervus nippon mandarinus*	China (Shantung and Chihli Provinces)	Entire	E	50	NA	NA
Deer, pampas	*Ozotoceros bezoarticus*	Brazil, Argentina, Uruguay, Bolivia, Paraguay.	do	E	15	NA	NA
Deer, Persian fallow	*Dama dama mesopotamica*	Iraq, Iran	do	E	3	NA	NA
Deer, Philippine	*Axis (=Cervus) porcinus calamianensis*	Philippines (Calamian Islands)	do	E	15	NA	NA
Deer, Ryukyu sika	*Cervus nippon keramae*	Japan (Ryukyu Islands)	do	E	50	NA	NA
Deer, Shansi sika	*Cervus nippon grassianus*	China (Shansi Province)	do	E	50	NA	NA
Deer, South China sika	*Cervus nippon kopschi*	Southern China	do	E	50	NA	NA
Deer, swamp (=barasingha)	*Cervus duvauceli*	India, Nepal	do	E	3	NA	NA
Deer, Yarkand	*Cervus elaphus yarkandensis*	China (Sinkiang)	do	E	50	NA	NA
Dhole (=Asiatic wild dog)	*Cuon alpinus*	U.S.S.R., Korea, China, India, Southeast Asia.	do	E	3	NA	NA
Dibbler	*Antechinus apicalis*	Australia	do	E	4	NA	NA
Dog, African wild	*Lycaon pictus*	Sub-Saharan Africa	do	E	139	NA	NA
Drill	*Papio leucophaeus*	Equatorial West Africa	do	E	15	NA	NA
Dugong	*Dugong dugon*	East Africa to southern Japan, including U.S.A. (Trust Territories).	do	E	4	NA	NA
Duiker, Jentink's	*Cephalophus jentinki*	Sierra Leone, Liberia, Ivory Coast	do	E	50	NA	NA
Eland, Western giant	*Taurotragus derbianus derbianus*	Senegal to Ivory Coast	do	E	50	NA	NA
Elephant, African	*Loxodonta africana*	Africa	do	T	40	NA	17.40(e)
Elephant, Asian	*Elephas maximus*	South-central and Southeast Asia	do	E	15	NA	NA
Ferret, black-footed	*Mustela nigripes*	Western U.S.A., Western Canada	do	E	1, 3	NA	NA
Fox, Northern swift	*Vulpes velox hebes*	U.S.A. (northern plains), Canada	Canada	E	3	NA	NA
Fox, San Joaquin kit	*Vulpes macrotis mutica*	U.S.A. (CA)	Entire	E	1	NA	NA
Fox, Simien	*Canis (Simenia) simensis*	Ethiopia	do	E	50	NA	NA
Gazelle, Clark's (=Dibatag)	*Ammodorcas clarkei*	Somalia, Ethiopia	do	E	3	NA	NA
Gazelle, Cuvier's	*Gazella cuvieri*	Morocco, Algeria, Tunisia	do	E	3	NA	NA
Gazelle, Mhorr	*Gazella dama mhorr*	Morocco	do	E	3	NA	NA
Gazelle, Moroccan (=Dorcas)	*Gazella dorcas massaesyla*	Morocco, Algeria, Tunisia	do	E	3	NA	NA
Gazelle, Rio de Oro Dama	*Gazella dama lozanoi*	Western Sahara	do	E	3	NA	NA
Gazelle, Arabian	*Gazella gazella*	Arabian Peninsula, Palestine, Sinai	do	E	50	NA	NA
Gazelle, sand	*Gazella subgutturosa marica*	Jordan, Arabian Peninsula	do	E	50	NA	NA
Gazelle, Saudi Arabian	*Gazella dorcas saudiya*	Israel, Iraq, Jordan, Syria, Arabian Peninsula.	do	E	50	NA	NA
Gazelle, Pelzeln's	*Gazella dorcas pelzelni*	Somalia	do	E	50	NA	NA
Gazelle, slender-horned (=Rhim)	*Gazella leptoceros*	Sudan, Egypt, Algeria, Libya	do	E	3	NA	NA
Gibbons	*Hylobates* spp. (including *Nomascus*)	China, India, Southeast Asia	do	E	3, 15	NA	NA

U.S.

Goat, wild (=Chiltan markhor)	*Capra aegagrus (=falconeri chiltanensis)*	Southwestern Asia	Chiltan Range of west-central Pakistan.	E	15	NA	NA
Goral	*Nemorhaedus goral*						

Goat, wild (=Chiltan markhor)	*Capra aegagrus* (=*falconeri chiltanensis*)	Southwestern Asia	Chiltan Range of west-central Pakistan.	E	15	NA	NA
Goral	*Nemorhaedus goral*	East Asia	Entire	E	15	NA	NA
Gorilla	*Gorilla gorilla*	Central and Western Africa	do	E	3	NA	NA
Guadalupe fur seal	*Arctocephalus townsendi*	U.S.A. (Farallon Islands of CA) south to Mexico (Islas Revillagigedo).	do	T	212	NA	227.11
Hare, hispid	*Caprolagus hispidus*	India, Nepal, Bhutan	do	E	15	NA	NA
Hartebeest, Swayne's	*Alcelaphus buselaphus swaynei*	Ethiopia, Somalia	do	E	3, 50	NA	NA
Hartebeest, Tora	*Alcelaphus buselaphus tora*	Ethiopia, Sudan, Egypt	do	E	50	NA	NA
Hog, pygmy	*Sus salvanius*	India, Nepal, Bhutan, Sikkim	do	E	3	NA	NA
Horse, Przewalski's	*Equus przewalskii*	Mongolia, China	do	E	15	NA	NA
Huemul, North Andean	*Hippocamelus antisensis*	Ecuador, Peru, Chile, Bolivia, Argentina	do	E	15	NA	NA
Huemul, South Andean	*Hippocamelus bisulcus*	Chile, Argentina	do	E	15	NA	NA
Hutia, Cabrera's	*Capromys angelcabrerai*	Cuba	do	E	233	NA	NA
Hutia, dwarf	*Capromys nana*	do	do	E	233	NA	NA
Hutia, large-eared	*Capromys auritus*	do	do	E	233	NA	NA
Hutia, little earth	*Capromys sanfelipensis*	do	do	E	233	NA	NA
Hyena, Barbary	*Hyaena hyaena barbara*	Morocco, Algeria, Tunisia	do	E	3	NA	NA
Hyena, brown	*Hyaena brunnea*	Southern Africa	do	E	3	NA	NA
Ibex, Pyrenean	*Capra pyrenaica pyrenaica*	Spain	do	E	3	NA	NA
Ibex, Walia	*Capra walie*	Ethiopia	do	E	3	NA	NA
Impala, black-faced	*Aepyceros melampus petersi*	Namibia, Angola	do	E	3	NA	NA
Indri	*Indri indri* (=entire genus)	Malagasy Republic (=Madagascar)	do	E	3	NA	NA
Jaguar	*Panthera onca*	U.S.A. (TX, NM, AZ), C. and S. America	Mexico southward	E	8	NA	NA
Jaguarundi	*Felis yagouaroundi cacomitli*	U.S.A. (TX), Mexico	Entire	E	15	NA	NA
Jaguarundi	*Felis yagouaroundi fossata*	Mexico, Nicaragua	do	E	15	NA	NA
Jaguarundi	*Felis yagouaroundi panamensis*	Nicaragua, Costa Rica, Panama	do	E	15	NA	NA
Jaguarundi	*Felis yagouaroundi tolteca*	U.S.A. (AZ), Mexico	do	E	15	NA	NA
Kangaroo, eastern gray	*Macropus giganteus* (all subspecies except *tasmaniensis*).	Australia	do	T	7	NA	17.40(a)
Kangaroo, red	*Macropus* (*Megaleia*) *rufus*	do	do	T	7	NA	17.40(a)
Kangaroo, Tasmanian forester	*Macropus giganteus tasmaniensis*	Australia (Tasmania)	do	E	6	NA	NA
Kangaroo, western gray	*Macropus fuliginosus*	Australia	do	T	7	NA	17.40(a)
Kouprey	*Bos sauveli*	Vietnam, Laos, Cambodia, Thailand	do	E	3	NA	NA
Langur, capped	*Presbytis pileata*	India, Burma, Bangladesh	do	E	15	NA	NA
Langur, entellus	*Presbytis entellus*	China (Tibet), India, Pakistan, Kashmir, Sri Lanka, Sikkim, Bangladesh.	do	E	15	NA	NA
Langur, Douc	*Pygathrix nemaeus*	Cambodia, Laos, Vietnam	do	E	3	NA	NA
Langur, Francois'	*Presbytis francoisi*	China (Kwangsi), Indochina	do	E	16	NA	NA
Langur, golden	*Presbytis geei*	India (Assam), Bhutan	do	E	15	NA	NA
Langur, long-tailed	*Presbytis potenziani*	Indonesia	do	T	16	NA	17.40(c)
Langur, Pagi Island	*Nasalis* (*Simias*) *concolor*	do	do	E	3	NA	NA
Langur, purple-faced	*Presbytis senex*	Sri Lanka (=Ceylon)	do	T	16	NA	17.40(c)
Langur, Tonkin snub-nosed	*Pygathrix* (*Rhinopithecus*) *avunculus*	Vietnam	do	T	16	NA	17.40(c)
Lechwe, red	*Kobus leche*	Southern Africa	do	T	3, 15, 106	NA	NA

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Lemurs	Lemuridae (incl. Cheirogaleidae, Lepilemuridae); all members of genera *Lemur, Phaner, Hapalemur, Lepilemur, Microcebus, Allocebus, Cheirogaleus, Varecia.*	Malagasy Republic (=Madagascar)	do	E	3, 15	NA	NA
Leopard	*Panthera pardus*	Africa, Asia	Wherever found, except where it is listed as Threatened as set forth below.	E	3, 5, 114	NA	NA
Do	do	do	In Africa, in the wild, south of, and including, the following countries: Gabon, Congo, Zaire, Uganda, Kenya.	T	3, 5, 114	NA	17.40(f)
Leopard, clouded	*Neofelis nebulosa*	Southeast and south-central Asia, Taiwan	Entire	E	3, 15	NA	NA
Leopard, snow	*Panthera uncia*	Central Asia	do	E	5	NA	NA
Linsang, spotted	*Prionodon pardicolor*	Nepal, Assam, Vietnam, Cambodia, Laos, Burma.	do	E	15	NA	NA
Lion, Asiatic	*Panthera leo persica*	Turkey to India	do	E	3	NA	NA
Loris, lesser slow	*Nycticebus pygmaeus*	Indochina	do	T	15	NA	17.40(c)
Lynx, Spanish	*Felis (=Lynx) pardina*	Spain, Portugal	do	E	3	NA	NA
Macaque, Formosan rock	*Macaca cyclopis*	Taiwan	do	T	15	NA	17.40(c)
Macaque, Japanese	*Macaca fuscata*	Japan (Shikoku, Kyushu and Honshu Islands).	do	T	15	NA	17.40(c)
Macaque, lion-tailed	*Macaca silenus*	India	do	E	3	NA	NA
Macaque, stump-tailed	*Macaca arctoides*	India (Assam) to southern China	do	T	15	NA	17.40(c)
Macaque, Toque	*Macaca sinica*	Sri Lanka (=Ceylon)	do	T	15	NA	17.40(c)
Manatee, Amazonian	*Trichechus inunguis*	South America (Amazon River Basin)	do	E	3	NA	NA
Manatee, West African	*Trichechus senegalensis*	West Coast of Africa from Senegal River to Cuanza River.	do	T	12	NA	NA
Manatee, West Indian (Florida)	*Trichechus manatus*	U.S.A. (southeastern), Caribbean Sea, South America.	do	E	1, 3	17.95(a)	NA
Mandrill	*Papio sphinx*	Equatorial West Africa	do	E	15	NA	NA
Mangabey, Tana River	*Cercocebus galeritus*	Kenya	do	E	3	NA	NA
Mangabey, white-collared	*Cercocebus torquatus*	Senegal to Ghana; Nigeria to Gabon	do	E	15	NA	NA
Margay	*Felis wiedii*	U.S.A. (TX), C. and S. America	Mexico southward	E	5	NA	NA
Markhor, Kabal	*Capra falconeri megaceros*	Afghanistan, Pakistan	Entire	E	15	NA	NA
Markhor, straight-horned	*Capra falconeri jerdoni*	do	do	E	15	NA	NA
Marmoset, buff-headed	*Callithrix flaviceps*	Brazil	do	E	130	NA	NA

Marmoset, buffy tufted-ear	*Callithrix jacchus aurita*	do	do	E	233	NA	NA
Marmoset, cotton-top	*Saguinus oedipus*	Costa Rica to Colombia	do	E	16	NA	NA
Marmoset, Goeldi's	*Callimico goeldii*	Brazil, Colombia, Ecuador, Peru, Bolivia	do	E	3	NA	NA
Marmot, Vancouver Island	*Marmota vancouverensis*	Canada (Vancouver Island)	do	E	130	NA	NA
Marsupial, eastern jerboa	*Antechinomys laniger*	Australia	do				
Marsupial-mouse, large desert	[illegible]						

Marmoset, buffy tufted-ear	*Callithrix jacchus aurita*	...do	...do	E	233	NA	NA
Marmoset, cotton-top	*Saguinus oedipus*	Costa Rica to Colombia	...do	E	16	NA	NA
Marmoset, Goeldi's	*Callimico goeldii*	Brazil, Colombia, Ecuador, Peru, Bolivia	...do	E	3	NA	NA
Marmot, Vancouver Island	*Marmota vancouverensis*	Canada (Vancouver Island)	...do	E	139	NA	NA
Marsupial, eastern jerboa	*Antechinomys laniger*	Australia	...do	E	4	NA	NA
Marsupial-mouse, large desert	*Sminthopsis psammophila*	...do	...do	E	4	NA	NA
Marsupial-mouse, long-tailed	*Sminthopsis longicaudata*	...do	...do	E	4	NA	NA
Marten, Formosan yellow-throated	*Martes flavigula chrysospila*	Taiwan	...do	E	3	NA	NA
Monkey, black colobus	*Colobus satanas*	Equatorial Guinea, People's Republic of Congo, Cameroon, Gabon.	...do	E	16	NA	NA
Monkey, black howler	*Alouatta pigra*	Mexico, Guatemala, Belize	...do	T	16	NA	17.40(c)
Monkey Diana	*Cercopithecus diana*	Coastal West Africa	...do	E	16	NA	NA
Monkey, howler	*Alouatta palliata* (=*villosa*)	Mexico to South America	...do	E	16	NA	NA
Monkey, L'hoest's	*Cercopithecus lhoesti*	Upper Eastern Congo Basin, Cameroon	...do	E	16	NA	NA
Monkey, Preuss' red colobus	*Colobus badius preussi*	Cameroon	...do	E	139	NA	NA
Monkey, proboscis	*Nasalis larvatus*	Borneo	...do	E	16	NA	NA
Monkey, red-backed squirrel	*Saimiri oerstedii*	Costa Rica, Panama	...do	E	3	NA	NA
Monkey, red-bellied	*Cercopithecus erythrogaster*	Western Nigeria	...do	E	16	NA	NA
Monkey, red-eared nose-spotted	*Cercopithecus erythrotis*	Nigeria, Cameroon, Fernando Po	...do	E	16	NA	NA
Monkey, spider	*Ateles geoffroyi frontatus*	Costa Rica, Nicaragua	...do	E	3	NA	NA
Monkey, spider	*Ateles geoffroyi panamensis*	Costa Rica, Panama	...do	E	3	NA	NA
Monkey, Tana River red colobus	*Colobus rufomitratus* (=*badius*) *rufomitratus*.	Kenya	...do	E	3, 16	NA	NA
Monkey, woolly spider	*Brachyteles arachnoides*	Brazil	...do	E	3	NA	NA
Monkey, yellow-tailed woolly	*Lagothrix flavicauda*	Andes of northern Peru	...do	E	16	NA	NA
Monkey, Zanzibar red colobus	*Colobus kirki*	Tanzania	...do	E	3	NA	NA
Mouse, Alabama beach	*Peromyscus polionotus ammobates*	U.S.A. (AL)	...do	E	183	17.95(a)	NA
Mouse, Australian native	*Zyzomys* (=*Notomys*) *pedunculatus*	Australia	...do	E	16	NA	NA
Mouse, Australian native	*Notomys aquilo*	...do	...do	E	16	NA	NA
Mouse, Choctawhatchee beach	*Peromyscus polionotus allophrys*	U.S.A. (FL)	...do	E	183	17.95(a)	NA
Mouse, Field's	*Pseudomys fieldi*	Australia	...do	E	4	NA	NA
Mouse, Gould's	*Pseudomys gouldii*	...do	...do	E	6	NA	NA
Mouse, Key Largo cotton	*Peromyscus gossypinus allapaticola*	U.S.A. (FL)	...do	E	131E, 160	NA	NA
Mouse, New Holland	*Pseudomys novaehollandiae*	Australia	...do	E	4	NA	NA
Mouse, Perdido Key beach	*Peromyscus polionotus trissyllepsis*	U.S.A. (AL, FL)	...do	E	183	17.95(a)	NA
Mouse, salt marsh harvest	*Reithrodontomys raviventris*	U.S.A. (CA)	...do	E	2	NA	NA
Mouse, Shark Bay	*Pseudomys praeconis*	Australia	...do	E	4	NA	NA
Mouse, Shortridge's	*Pseudomys shortridgei*	...do	...do	E	4	NA	NA
Mouse, Smoky	*Pseudomys fumeus*	...do	...do	E	4	NA	NA
Mouse, western	*Pseudomys occidentalis*	...do	...do	E	4	NA	NA
Muntjac, Fea's	*Muntiacus feae*	Northern Thailand, Burma	...do	E	50	NA	NA
Native-cat, eastern	*Dasyurus viverrinus*	Australia	...do	E	6	NA	NA
Numbat	*Myrmecobius fasciatus*	...do	...do	E	4, 6	NA	NA
Ocelot	*Felis pardalis*	U.S.A. (AZ, TX) to C. and S. America	...do	E	6, 119	NA	NA
Orangutan	*Pongo pygmaeus*	Borneo, Sumatra	...do	E	3	NA	NA
Oryx, Arabian	*Oryx leucoryx*	Arabian Peninsula	...do	E	3	NA	NA
Otter, Cameroon clawless	*Aonyx* (*Paraonyx*) *congica microdon*	Cameroon, Nigeria	...do	E	3	NA	NA

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Otter, giant	*Pteronura brasiliensis*	South America	do	E	3	NA	NA
Otter, long-tailed	*Lutra longicaudis* (incl. *platensis*)	do	do	E	3, 15	NA	NA
Otter, marine	*Lutra felina*	Peru south to Straits of Magellan	do	E	15	NA	NA
Otter, southern river	*Lutra provocax*	Chile, Argentina	do	E	15	NA	NA
Otter, southern sea	*Enhydra lutris nereis*	West coast U.S.A. (WA, OR, CA) south to Mexico (Baja California).	do	T	21	NA	NA
Panda, giant	*Ailuropoda melanoleuca*	People's Republic of China	do	E	130	NA	NA
Pangolin (=scaly anteater)	*Manis temmincki*	Africa	do	E	15	NA	NA
Panther, Florida	*Felis concolor coryi*	U.S.A. (LA and AR east to SC and FL)	do	E	1	NA	NA
Planigale, little	*Planigale ingrami subtilissima* (formerly *P. subtilissima*).	Australia	do	E	4	NA	NA
Planigale, southern	*Planigale tenuirostris*	do	do	E	4	NA	NA
Porcupine, thin-spined	*Chaetomys subspinosus*	Brazil	do	E	3	NA	NA
Possum, Leadbeater's	*Gymnobelideus leadbeateri*	do	do	E	233	NA	NA
Possum, mountain pygmy	*Burramys parvus*	Australia	do	E	4	NA	NA
Possum, scaly-tailed	*Wyulda squamicaudata*	do	do	E	4	NA	NA
Prairie dog, Mexican	*Cynomys mexicanus*	Mexico	do	E	3	NA	NA
Prairie dog, Utah	*Cynomys parvidens*	U.S.A. (UT)	do	T	6, 149	NA	17.40(g)
Pronghorn, peninsular	*Antilocapra americana peninsularis*	Mexico (Baja California)	do	E	10	NA	NA
Pronghorn, Sonoran	*Antilocapra americana sonoriensis*	U.S.A. (AZ), Mexico	do	E	1, 3	NA	NA
Pudu	*Pudu pudu*	Southern South America	do	E	15	NA	NA
Puma, Costa Rican	*Felis concolor costaricensis*	Nicaragua, Panama, Costa Rica	do	E	15	NA	NA
Quokka	*Setonix brachyurus*	Australia	do	E	8	NA	NA
Rabbit, Ryukyu	*Pentalagus furnessi*	Japan (Ryukyu Islands)	do	E	60	NA	NA
Rabbit, volcano	*Romerolagus diazi*	Mexico	do	E	3	NA	NA
Rat, false water	*Xeromys myoides*	Australia	do	E	4	NA	NA
Rat, Fresno kangaroo	*Dipodomys nitratoides exilis*	U.S.A. (CA)	do	E	170	17.95(a)	NA
Rat, Morro Bay kangaroo	*Dipodomys heermanni morroensis*	do	do	E	2	17.95(a)	NA
Rat, stick-nest	*Leporillus conditor*	Australia	do	E	6	NA	NA
Rat-kangaroo, brush-tailed	*Bettongia penicillata*	do	do	E	4	NA	NA
Rat-kangaroo, Gaimard's	*Bettongia gaimardi*	do	do	E	6	NA	NA
Rat-kangaroo, Lesuer's	*Bettongia lesueur*	do	do	E	4	NA	NA
Rat-kangaroo, plain	*Caloprymnus campestris*	do	do	E	4	NA	NA
Rat-kangaroo, Queensland	*Bettongia tropica*	do	do	E	4	NA	NA
Rhinoceros, black	*Diceros bicornis*	Sub-Saharan Africa	do	E	97	NA	NA
Rhinoceros, great Indian	*Rhinoceros unicornis*	India, Nepal	do	E	4	NA	NA
Rhinoceros, Javan	*Rhinoceros sondaicus*	Indonesia, Indochina, Burma, Thailand, Sikkim, Bangladesh, Malaysia.	do	E	3	NA	NA
Rhinoceros, northern white	*Ceratotherium simum cottoni*	Zaire, Sudan, Uganda, Central African Republic.	do	E	3	NA	NA
Rhinoceros, Sumatran	*Dicerorhinus* (=*Didermoceros*) *sumatrensis*.	Bangladesh to Vietnam to Indonesia (Borneo).	do	E	3	NA	NA
Saiga, Mongolian (antelope)	*Saiga tatarica mongolica*	Mongolia	do	E	15	NA	NA

Saki, southern bearded	*Chiropotes satanas satanas*	Brazil	do	E	233	NA	NA
Saki, white-nosed	*Chiropotes albinasus*	do	do	E	3	NA	NA
Seal, Caribbean monk	*Monachus tropicalis*	Caribbean Sea, Gulf of Mexico	do	E	1, 2, 46	NA	NA
Seal, Hawaiian monk	*Monachus schauinslandi*	U.S.A. (HI)	do	E	10	NA	NA
Seal, Mediterranean monk	*Monachus monachus*	Mediterranean, Northwest African Coast and Black Sea.	do	E	3	NA	NA
Seladang (=Gaur)	*Bos gaurus*	Bangladesh, Southeast Asia, India	do	E	3	NA	NA
Serow	*Capricornis sumatraensis*	East Asia, Sumatra	do				
Serval, Barbary	*Felis serval constantina*	Al[illegible]	do				

Saki, southern bearded	*Chiropotes satanas satanas*	Brazil	do	E	833	NA	NA
Saki, white-nosed	*Chiropotes albinasus*	do	do	E	3	NA	NA
Seal, Caribbean monk	*Monachus tropicalis*	Caribbean Sea, Gulf of Mexico	do	E	1, 8, 45	NA	NA
Seal, Hawaiian monk	*Monachus schauinslandi*	U.S.A. (HI)	do	E	16	NA	NA
Seal, Mediterranean monk	*Monachus monachus*	Mediterranean, Northwest African Coast and Black Sea	do	E	3	NA	NA
Seladang (=Gaur)	*Bos gaurus*	Bangladesh, Southeast Asia, India	do	E	3	NA	NA
Serow	*Capricornis sumatraensis*	East Asia, Sumatra	do	E	15	NA	NA
Serval, Barbary	*Felis serval constantina*	Algeria	do	E	3	NA	NA
Shapo	*Ovis vignei vignei*	Kashmir	do	E	15	NA	NA
Shou	*Cervus elaphus wallichi*	Tibet, Bhutan	do	E	3	NA	NA
Shrew, Dismal Swamp southeastern	*Sorex longirostris fisheri*	U.S.A. (VA, NC)	do	T	246	NA	NA
Siamang	*Symphalangus syndactylus*	Malaysia, Indonesia	do	E	15	NA	NA
Sifakas	*Propithecus* spp. (all species)	Malagasy Republic (=Madagascar)	do	E	4	NA	NA
Sloth, Brazilian three-toed	*Bradypus torquatus*	Brazil	do	E	3, 4	NA	NA
Solenodon, Cuban	*Solenodon (Atopogale) cubanus*	Cuba	do	E	3	NA	NA
Solenodon, Haitian	*Solenodon paradoxus*	Dominican Republic, Haiti	do	E	3	NA	NA
Squirrel, Carolina northern flying	*Glaucomys sabrinus coloratus*	U.S.A. (NC, TN)	do	E	189	NA	NA
Squirrel, Delmarva Peninsula fox	*Sciurus niger cinereus*	U.S.A. (Delmarva Peninsula to southeast PA).	Entire, except Sussex Co., DE.	E	1, 161, 168	NA	NA
Do	do	do	U.S.A. (DE—Sussex County).	XN	161	NA	17.84(a)
Squirrel, Virginia northern flying	*Glaucomys sabrinus fuscus*	U.S.A. (VA, WV)	Entire	E	189	NA	NA
Stag, Barbary	*Cervus elaphus barbarus*	Tunisia, Algeria	do	E	3	NA	NA
Stag, Kashmir	*Cervus elaphus hanglu*	Kashmir	do	E	3	NA	NA
Suni, Zanzibar	*Neotragus (Nesotragus) moschatus moschatus.*	Zanzibar (and nearby islands)	do	E	60	NA	NA
Tahr, Arabian	*Hemitragus jayakari*	Oman	do	E	50	NA	NA
Tamaraw	*Bubalus mindorensis*	Philippines	do	E	4	NA	NA
Tamarin, golden-rumped (=golden-headed Tamarin; =golden-lion Marmoset).	*Leontopithecus (=Leontideus)* spp. (all species).	Brazil	do	E	3	NA	NA
Tamarin, pied	*Saguinus bicolor*	do	do	E	16	NA	NA
Tamarin, white-footed	*Saguinus leucopus*	Colombia	do	T	16	NA	17.40(c)
Tapir, Asian	*Tapirus indicus*	Burma, Laos, Cambodia, Vietnam, Malaysia, Indonesia, Thailand.	do	E	15	NA	NA
Tapir, Brazilian	*Tapirus terrestris*	Colombia and Venezuela south to Paraguay and Argentina.	do	E	3	NA	NA
Tapir, Central American	*Tapirus bairdii*	Southern Mexico to Colombia and Ecuador.	do	E	3	NA	NA
Tapir, mountain	*Tapirus pinchaque*	Colombia, Ecuador and possibly Peru and Venezuela.	do	E	3	NA	NA
Tarsier, Philippine	*Tarsius syrichta*	Philippines	do	T	16	NA	17.40(c)
Tiger	*Panthera tigris*	Temperate and Tropical Asia	do	E	3, 5	NA	NA
Tiger, Tasmanian (=Thylacine)	*Thylacinus cynocephalus*	Australia	do	E	3	NA	NA
Uakari (all species)	*Cacajao* spp. (all species)	Peru, Brazil, Ecuador, Colombia, Venezuela.	do	E	3	NA	NA
Urial	*Ovis musimon (=orientalis) ophion*	Cyprus	do	E	15	NA	NA

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Vicuna	*Vicugna vicugna*	South America (Andes)	do	E	3	NA	NA
Vole, Amargosa	*Microtus californicus scirpensis*	U.S.A. (CA)	do	E	161	17.95(a)	NA
Wallaby, banded hare	*Lagostrophus fasciatus*	Australia	do	E	4	NA	NA
Wallaby, bridled nail-tailed	*Onychogalea fraenata*	do	do	E	4	NA	NA
Wallaby, crescent nail-tailed	*Onychogalea lunata*	do	do	E	4	NA	NA
Wallaby, Parma	*Macropus parma*	do	do	E	4	NA	NA
Wallaby, Western hare	*Lagorchestes hirsutus*	do	do	E	4	NA	NA
Wallaby, yellow-footed rock	*Petrogale xanthopus*	do	do	E	4	NA	NA
Whale, blue	*Balaenoptera musculus*	Oceanic	do	E	3	NA	NA
Whale, bowhead	*Balaena mysticetus*	Oceanic (north latitudes only)	do	E	3	NA	NA
Whale, finback	*Balaenoptera physalus*	Oceanic	do	E	3	NA	NA
Whale, gray	*Eschrichtius robustus*	North Pacific Ocean: coastal and Bering Sea	do	E	3	NA	NA
Whale, humpback	*Megaptera novaeangliae*	Oceanic	do	E	3	NA	NA
Whale, right	*Balaena glacialis*	do	do	E	3	NA	NA
Whale, Sei	*Balaenoptera borealis*	do	do	E	3	NA	NA
Whale, sperm	*Physeter catodon*	do	do	E	3	NA	NA
Wolf, gray	*Canis lupus*	Holarctic	U.S.A. (48 conterminous States, except MN), Mexico.	E	1, 6, 13, 15, 35	17.95(a)	NA
Do	do	do	U.S.A. (MN)	T	35	17.95(a)	17.40(d)
Wolf, maned	*Chrysocyon brachyurus*	Argentina, Bolivia, Brazil, Paraguay, Uruguay.	Entire	E	4	NA	NA
Wolf, red	*Canis rufus*	U.S.A. (southeastern U.S.A. west to central TX).	do	E	1	NA	NA
Wombat, hairy-nosed (=Barnard's and Queensland hairy-nosed).	*Lasiorhinus krefftii* (formerly *L. barnardi* and *L. gillespiei*).	Australia	do	E	4, 6	NA	NA
Woodrat, Key Largo	*Neotoma floridana smalli*	U.S.A. (FL)	do	E	131E, 160	NA	NA
Yak, wild	*Bos grunniens*	China (Tibet), India	do	E	3	NA	NA
Zebra, Grevy's	*Equus grevyi*	Kenya, Ethiopia, Somalia	do	T	64	NA	NA
Zebra, Hartmann's mountain	*Equus zebra hartmannae*	Namibia, Angola	do	T	64, 111	NA	NA
Zebra, mountain	*Equus zebra zebra*	South Africa	do	E	15, 111	NA	NA
Birds							
Akepa, Hawaii (honeycreeper)	*Loxops coccineus coccineus*	U.S.A. (HI)	do	E	2	NA	NA
Akepa, Maui (honeycreeper)	*Loxops coccineus ochraceus*	do	do	E	2	NA	NA
Akialoa, Kauai (honeycreeper)	*Hemignathus procerus*	do	do	E	1	NA	NA
Akiapolaau (honeycreeper)	*Hemignathus munroi* (=*wilsoni*)	do	do	E	1	NA	NA
Albatross, short-tailed	*Diomedea albatrus*	North Pacific Ocean: Japan, U.S.S.R., U.S.A. (AK, CA, HI, OR, WA).	Entire, except U.S.A.	E	3	NA	NA
Blackbird, yellow-shouldered	*Agelaius xanthomus*	U.S.A. (PR)	Entire	E	17	17.95(b)	NA

Bobwhite, masked (quail)	*Colinus virginianus ridgwayi*	U.S.A. (AZ), Mexico (Sonora)	do	E	1, 3	NA	NA
Booby, Abbott's	*Sula abbotti*	Indian Ocean: Christmas Island	do	E	15	NA	NA
Bristlebird, western	*Dasyornis brachypterus longirostris*	Australia	do	E	3	NA	NA
Bristlebird, western rufous	*Dasyornis broadbenti litoralis*	do	do	E	15	NA	NA
Broadbill, Guam	*Myiagra freycineti*	Western Pacific Ocean: U.S.A. (Guam)	do	E	156	NA	NA
Bulbul, Mauritius olivaceous	*Hypsipetes borbonicus olivaceus*	Indian Ocean: Mauritius	do	E	3	NA	NA
Bullfinch, Sao Miguel (finch)	*Pyrrhula pyrrhula murina*	Eastern Atlantic Ocean: Azores	do	E			
Bushwren, New Zealand							

Bobwhite, masked (quail)	*Colinus virginianus ridgwayi*	U.S.A. (AZ), Mexico (Sonora)	do	E	1, 3	NA	NA
Booby, Abbott's	*Sula abbotti*	Indian Ocean: Christmas Island	do	E	15	NA	NA
Bristlebird, western	*Dasyornis brachypterus longirostris*	Australia	do	E	3	NA	NA
Bristlebird, western rufous	*Dasyornis broadbenti litoralis*	do	do	E	15	NA	NA
Broadbill, Guam	*Myiagra freycineti*	Western Pacific Ocean: U.S.A. (Guam)	do	E	156	NA	NA
Bulbul, Mauritius olivaceous	*Hypsipetes borbonicus olivaceus*	Indian Ocean: Mauritius	do	E	3	NA	NA
Bullfinch, Sao Miguel (finch)	*Pyrrhula pyrrhula murina*	Eastern Atlantic Ocean: Azores	do	E	3	NA	NA
Bushwren, New Zealand	*Xenicus longipes*	New Zealand	do	E	3	NA	NA
Bustard, great Indian	*Choriotis nigriceps*	India, Pakistan	do	E	3	NA	NA
Cahow (=Bermuda Petrel)	*Pterodroma cahow*	North Atlantic Ocean: Bermuda	do	E	3	NA	NA
Condor, Andean	*Vultur gryphus*	Colombia to Chile and Argentina	do	E	4	NA	NA
Condor, California	*Gymnogyps californianus*	U.S.A. (OR, CA), Mexico (Baja California)	do	E	1	17.95(b)	NA
Coot, Hawaiian (=alae keo keo)	*Fulica americana alai*	U.S.A. (HI)	do	E	2	NA	NA
Cotinga, banded	*Cotinga maculata*	Brazil	do	E	15	NA	NA
Cotinga, white-winged	*Xipholena atropurpurea*	do	do	E	15	NA	NA
Crane, black-necked	*Grus nigricollis*	China (Tibet)	do	E	15	NA	NA
Crane, Cuba sandhill	*Grus canadensis nesiotes*	West Indies: Cuba	do	E	15	NA	NA
Crane, hooded	*Grus monacha*	Japan, U.S.S.R.	do	E	4	NA	NA
Crane, Japanese	*Grus japonensis*	China, Japan, Korea, U.S.S.R.	do	E	3	NA	NA
Crane, Mississippi sandhill	*Grus canadensis pulla*	U.S.A. (MS)	do	E	6	17.95(b)	NA
Crane, Siberian white	*Grus leucogeranus*	U.S.S.R. (Siberia) to India, including Iran and China.	do	E	4	NA	NA
Crane, white-naped	*Grus vipio*	Mongolia	do	E	15	NA	NA
Crane, whooping	*Grus americana*	Canada, U.S.A. (Rocky Mountains east to Carolinas), Mexico.	do	E	1, 3	17.95(b)	NA
Creeper, Hawaii	*Oreomystis (=Loxops) mana*	U.S.A. (HI)	do	E	10	NA	NA
Creeper, Molokai (=kakawahie)	*Paroreomyza (=Oreomystis, =Loxops) flammea.*	do	do	E	2	NA	NA
Creeper, Oahu (=alauwahio)	*Paroreomyza (=Oreomystis, =Loxops) maculata.*	do	do	E	2	NA	NA
Crow, Hawaiian (='alala)	*Corvus hawaiiensis (=tropicus)*	do	do	E	1	NA	NA
Crow, Mariana	*Corvus kubaryi*	Western Pacific Ocean: U.S.A. (Guam, Rota).	do	E	156	NA	NA
Cuckoo-shrike, Mauritius	*Coquus (=Coracina) typicus*	Indian Ocean: Mauritius	do	E	3	NA	NA
Cuckoo-shrike, Reunion	*Coquus (=Coracina) newtoni*	Indian Ocean: Reunion	do	E	3	NA	NA
Curassow, razor-billed	*Mitu (=Crax) mitu mitu*	Brazil (Eastern)	do	E	15	NA	NA
Curassow, red-billed	*Crax blumenbachii*	Brazil	do	E	4	NA	NA
Curassow, Trinidad white-headed	*Pipile pipile pipile*	West Indies: Trinidad	do	E	3	NA	NA
Curlew, Eskimo	*Numenius borealis*	Alaska and northern Canada to Argentina	do	E	1, 3	NA	NA
Dove, cloven-feathered	*Drepanoptila holosericea*	Southwest Pacific Ocean: New Caledonia	do	E	3	NA	NA
Dove, Grenada gray-fronted	*Leptotila rufaxilla wellsi*	West Indies: Grenada	do	E	3	NA	NA
Duck, Hawaiian (=koloa)	*Anas wyvilliana*	U.S.A. (HI)	do	E	1	NA	NA
Duck, Laysan	*Anas laysanensis*	do	do	E	1	NA	NA
Duck, pink-headed	*Rhodonessa caryophyllacea*	India	do	E	15	NA	NA
Duck, white-winged wood	*Cairina scutulata*	India, Malaysia, Indonesia, Thailand	do	E	3	NA	NA

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Eagle, bald	*Haliaeetus leucocephalus*	North America south to northern Mexico	U.S.A. (conterminous States, except WA, OR, MN, WI, MI).	E	1, 34	NA	NA
Do	do	do	U.S.A. (WA, OR, MN, WI, MI).	T	34	NA	17.41(a)
Eagle, Greenland white-tailed	*Haliaeetus albicilla groenlandicus*	Greenland and adjacent Atlantic islands	do	E	18	NA	NA
Eagle, harpy	*Harpia harpyja*	Mexico south to Argentina	do	E	18	NA	NA
Eagle, Philippine (=monkey-eating)	*Pithecophaga jefferyi*	Philippines	do	E	3	NA	NA
Eagle, Spanish imperial	*Aquila heliaca adalberti*	Spain, Morocco, Algeria	Entire	E	3	NA	NA
Egret, Chinese	*Egretta eulophotes*	China, Korea	do	E	3	NA	NA
Falcon, American peregrine	*Falco peregrinus anatum*	Nests from central Alaska across north-central Canada to central Mexico, winters south to South America.	do	E	2, 3, 145	17.95(b)	NA
Falcon, Arctic peregrine	*Falco peregrinus tundrius*	Nests from northern Alaska to Greenland; winters south to Central and South America.	do	T	2, 3, 145	NA	NA
Falcon, Eurasian peregrine	*Falco peregrinus peregrinus*	Europe, Eurasia south to Africa and Mideast.	do	E	15	NA	NA
Falcon, northern aplomado	*Falco femoralis septentrionalis*	U.S.A. (AZ, NM, TX), Mexico, Guatemala	do	E	218	NA	NA
Falcon, peregrine	*Falco peregrinus*	Worldwide, except Antarctica and most Pacific Islands.	Wherever found in wild in the conterminous 48 States.	E(S/A)	145	NA	NA
Finch, Laysan (honeycreeper)	*Telespyza (=Psittirostra) cantans*	U.S.A. (HI)	Entire	E	1	NA	NA
Finch, Nihoa (honeycreeper)	*Telespyza (=Psittirostra) ultima*	do	do	E	1	NA	NA
Flycatcher, Euler's	*Empidonax euleri johnstonei*	West Indies: Grenada	do	E	3	NA	NA
Flycatcher, Seychelles paradise	*Terpsiphone corvina*	Indian Ocean: Seychelles	do	E	3	NA	NA
Flycatcher, Tahiti	*Pomarea nigra*	South Pacific Ocean: Tahiti	do	E	3	NA	NA
Fody, Seychelles (weaver-finch)	*Foudia sechellarum*	Indian Ocean: Seychelles	do	E	3	NA	NA
Frigatebird, Andrew's	*Fregata andrewsi*	East Indian Ocean	do	E	15	NA	NA
Goose, Aleutian Canada	*Branta canadensis leucopareia*	U.S.A. (AK, CA, OR, WA), Japan	do	E	1, 3	NA	NA
Goose, Hawaiian (=nene)	*Nesochen (=Branta) sandvicensis*	U.S.A. (HI)	do	E	1	NA	NA
Goshawk, Christmas Island	*Accipiter fasciatus natalis*	Indian Ocean: Christmas Island	do	E	3	NA	NA
Grackle, slender-billed	*Quiscalus (=Cassidix) palustris*	Mexico	do	E	3	NA	NA
Grasswren, Eyrean (flycatcher)	*Amytornis goyderi*	Australia	do	E	3	NA	NA
Grebe, Atitlan	*Podilymbus gigas*	Guatemala	do	E	3	NA	NA
Greenshank, Nordmann's	*Tringa guttifer*	U.S.S.R., Japan, south to Malaya, Borneo	do	E	15	NA	NA
Guan, horned	*Oreophasis derbianus*	Guatemala, Mexico	do	E	3	NA	NA
Gull, Audouin's	*Larus audouinii*	Mediterranean Sea	do	E	3	NA	NA
Gull, relict	*Larus relictus*	India, China	do	E	18	NA	NA
Hawk, Anjouan Island sparrow	*Accipiter francesii pusillus*	Indian Ocean: Comoro Islands	do	E	3	NA	NA
			do	E	3	NA	NA

Hawk, Galapagos	*Buteo galapagoensis*	Ecuador (Galapagos Islands)	do	E	3	NA	NA
Hawk, Hawaiian (=io)	*Buteo solitarius*	U.S.A. (HI)	do	E	1	NA	NA
Hermit, hook-billed (hummingbird)	*Glaucis (=Ramphodon) dohrnii*	Brazil	do	E	15	NA	NA
Honeycreeper, crested (='akohekohe)	*Palmeria dolei*	U.S.A. (HI)	do	E	1	NA	NA
Hornbill, helmeted	*Rhinoplax vigil*	Thailand, Malaysia	do	E	15	NA	NA
Honeyeater, helmeted	*Meliphaga cassidix*	Australia	do	E	4	NA	NA
Ibis, Japanese crested	*Nipponia nippon*	China, Japan, U.S.S.R., Korea	do	E	3	NA	NA
Kagu	*Rhynochetos jubatus*	South Pacific Ocean: New Caledonia	do				

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Turtle, Kemp's (=Atlantic) Ridley sea	*Lepidochelys kempii*	Tropical and temperate seas in Atlantic Basin.	...do	E	4	NA	NA
Turtle, leatherback sea	*Dermochelys coriacea*	Tropical, temperate, and subpolar seas	...do	E	3	17.95(c), 226.71	NA
Turtle, loggerhead sea	*Caretta caretta*	Circumglobal in tropical and temperate seas and oceans.	...do	T	42	NA	17.42(b) and Parts 220 and 227.
Turtle, Olive (Pacific) Ridley sea	*Lepidochelys olivacea*	Tropical and temperate seas in Pacific Basin.	Wherever found except where listed as endangered below.	T	42	NA	17.42(b) and Parts 220 and 227.
Do	...do	...do	Breeding colony populations on Pacific coast of Mexico.	E	42	NA	NA
Turtle, peacock softshell	*Trionyx hurum*	India, Bangladesh	Entire	E	15	NA	NA
Turtle, Plymouth red-bellied	*Pseudemys (=Chrysemys) rubriventris bangsi.*	U.S.A. (MA)	...do	E	80	17.95(c)	NA
Turtle, short-necked or western swamp	*Pseudemydura umbrina*	Australia	...do	E	3	NA	NA
Turtle, spotted pond	*Geoclemys (=Damonia) hamiltonii*	North India, Pakistan	...do	E	15	NA	NA
Turtle, three-keeled Asian	*Melanochelys (=Geoemyda, Nicoria) tricarinata.*	Central India to Bangladesh and Burma	...do	E	15	NA	NA
Viper, Lar Valley	*Vipera latifii*	Iran	...do	E	129	NA	NA
AMPHIBIANS							
Coqui, golden	*Eleutherodactylus jasperi*	U.S.A. (PR)	...do	T	29	17.95(d)	NA
Frog, Israel painted	*Discoglossus nigriventer*	Israel	...do	E	3	NA	NA
Frog, Panamanian golden	*Atelopus varius zeteki*	Panama	...do	E	15	NA	NA
Frog, Stephen Island	*Leiopelma hamiltoni*	New Zealand	...do	E	3	NA	NA
Salamander, Chinese giant	*Andrias davidianus davidianus*	Western China	...do	E	15	NA	NA
Salamander, desert slender	*Batrachoseps aridus*	U.S.A. (CA)	...do	E	6	NA	NA
Salamander, Japanese giant	*Andrias davidianus japonicus*	Japan	...do	E	15	NA	NA
Salamander, Red Hills	*Phaeognathus hubrichti*	U.S.A. (AL)	...do	T	18	NA	NA
Salamander, San Marcos	*Eurycea nana*	U.S.A. (TX)	...do	T	66	17.95(d)	17.43(a)
Salamander, Santa Cruz long-toed	*Ambystoma macrodactylum croceum*	U.S.A. (CA)	...do	E	1	NA	NA
Salamander, Texas blind	*Typhlomolge rathbuni*	U.S.A. (TX)	...do	E	1	NA	NA
Toad, African viviparous	*Nectophrynoides spp.*	Tanzania, Guinea, Ivory Coast, Cameroon, Liberia, Ethiopia.	...do	E	16	NA	NA
Toad, Cameroon	*Bufo superciliaris*	Equatorial Africa	...do	E	15	NA	NA
Toad, Houston	*Bufo houstonensis*	U.S.A. (TX)	...do	E	2	17.95(d)	NA
Toad, Monte Verde	*Bufo periglenes*	Costa Rica	...do	E	16	NA	NA

Toad, Wyoming	*Bufo hemiophrys baxteri*	U.S.A. (WY)	...do	E	136	NA	NA
FISHES							
Ala Balik (trout)	*Salmo platycephalus*	Turkey	Entire	E	3	NA	NA
Ayumodoki (loach)	*Hymenophysa (=Botia) curta*	Japan	...do	E	3	NA	NA
Blindcat, Mexican (catfish)	*Prietella phreatophila*	Mexico	...do	[illegible]	[illegible]		
Bonytongue, Asian	*Scleropages formosus*	[illegible]	...do				

Toad, Wyoming	*Bufo hemiophrys baxteri*	U.S.A. (WY)	do	E	136	NA	NA
FISHES							
Ala Balik (trout)	*Salmo platycephalus*	Turkey	Entire	E	3	NA	NA
Ayumodoki (loach)	*Hymenophysa (=Botia) curta*	Japan	do	E	3	NA	NA
Blindcat, Mexican (catfish)	*Prietella phreatophila*	Mexico	do	E	3	NA	NA
Bonytongue, Asian	*Scleropages formosus*	Thailand, Indonesia, Malaysia	do	E	15	NA	NA
Catfish [no common name]	*Pangasius sanitwongsei*	Thailand	do	E	3	NA	NA
Catfish, giant	*Pangasianodon gigas*	do	do	E	3	NA	NA
Catfish, Yaqui	*Ictalurus pricei*	U.S.A. (AZ), Mexico	do	T	157	17.95(e)	17.44(g)
Cavefish, Alabama	*Speoplatyrhinus poulsoni*	U.S.A. (AL)	do	T	28	17.95(e)	NA
Cavefish, Ozark	*Amblyopsis rosae*	U.S.A. (AR, MO, OK)	do	T	164	NA	NA
Chub, bonytail	*Gila elegans*	U.S.A. (AZ, CA, CO, NV, UT, WY)	do	E	82	NA	NA
Chub, Borax Lake	*Gila boraxobius*	U.S.A. (OR)	do	E	124	17.95(e)	NA
Chub, Chihuahua	*Gila nigrescens*	U.S.A. (NM), Mexico (Chihuahua)	do	T	132	NA	17.44(g)
Chub, humpback	*Gila cypha*	U.S.A. (AZ, CO, UT, WY)	do	E	1	NA	NA
Chub, Hutton tui	*Gila bicolor ssp*	U.S.A. (OR)	do	T	174	NA	17.44(j)
Chub, Mohave tui	*Gila bicolor mohavensis*	U.S.A. (CA)	do	E	2	NA	NA
Chub, Owens tui	*Gila bicolor snyderi*	do	do	E	185	17.95(e)	NA
Chub, Pahranagat roundtail	*Gila robusta jordani*	U.S.A. (NV)	do	E	2	NA	NA
Chub, slender	*Hybopsis cahni*	U.S.A. (TN, VA)	do	T	28	17.95(e)	17.44(c)
Chub, Sonora	*Gila ditaenia*	U.S.A., (AZ), Mexico	do	T	227	17.95(e)	17.44(c)
Chub, spotfin	*Hybopsis monacha*	U.S.A. (AL, GA, NC, TN, VA)	do	T	28	17.95(e)	17.44(c)
Chub, Yaqui	*Gila purpurea*	U.S.A. (AZ), Mexico	do	E	157	17.95(e)	NA
Cicek (minnow)	*Acanthorutilus handlirschi*	Turkey	do	E	3	NA	NA
Cui-ui	*Chasmistes cujus*	U.S.A. (NV)	do	E	1	NA	NA
Dace, Ash Meadows speckled	*Rhinichthys osculus nevadensis*	do	do	E	117E, 127E, 130	17.95(e)	NA
Dace, desert	*Eremichthys acros*	do	do	T	210	17.95(e)	17.44(m)
Dace, Foskett speckled	*Rhinichthys osculus ssp*	U.S.A. (OR)	do	T	174	NA	17.44(j)
Dace, Kendall Warm Springs	*Rhinichthys osculus thermalis*	U.S.A. (WY)	do	E	2	NA	NA
Dace, Moapa	*Moapa coriacea*	U.S.A. (NV)	do	E	1	NA	NA
Darter, amber	*Percina antesella*	U.S.A. (GA, TN)	do	E	196	17.95(e)	NA
Darter, bayou	*Etheostoma rubrum*	U.S.A. (MS)	do	T	10	NA	17.44(b)
Darter, fountain	*Etheostoma fonticola*	U.S.A. (TX)	do	E	2	17.95(e)	NA
Darter, leopard	*Percina pantherina*	U.S.A. (AR, OK)	do	T	31	17.95(e)	17.44(d)
Darter, Maryland	*Etheostoma sellare*	U.S.A. (MD)	do	E	1	NA	NA
Darter, Niangua	*Etheostoma nianguae*	U.S.A. (MO)	do	T	185	17.95(e)	17.44(k)
Darter, Okaloosa	*Etheostoma okaloosae*	U.S.A. (FL)	do	E	6	NA	NA
Darter, slackwater	*Etheostoma boschungi*	U.S.A. (AL, TN)	do	T	28	17.95(e)	17.44(c)
Darter, snail	*Percina tanasi*	U.S.A. (AL, GA, TN)	do	T	12, 150	NA	NA
Darter, watercress	*Etheostoma nuchale*	U.S.A. (AL)	do	E	2	NA	NA
Gambusia, Big Bend	*Gambusia gaigei*	U.S.A. (TX)	do	E	1	NA	NA
Gambusia, Clear Creek	*Gambusia heterochir*	do	do	E	1	NA	NA
Gambusia, Amistad	*Gambusia amistadensis*	do	do	E	83	NA	NA
Gambusia, Pecos	*Gambusia nobilis*	U.S.A. (NM, TX)	do	E	2	NA	NA
Gambusia, San Marcos	*Gambusia georgei*	U.S.A. (TX)	do	E	86	17.95(e)	NA

REFERENCE 20

<u>Hanford Reservation Area Workers Census</u>, BNWL-2298, July 1977

Hanford Reservation Area Worker Census

A Research Report for the Rockwell Hanford Operations

Battelle

TABLE 1. Concentration of Hanford Reservation Workers by Site

Site	Number of Workers	Percent of Total
100	760	5
200 E&W	2,355	16
WPPSS #1,2,&4	2,905	20
FFTF	2,420	16
300	3,110	21
Battelle, et al.	3,345	22
TOTAL	14,895	100

While the worker counts being reported by Reservation employers are usually shown concentrated around a designated site, in reality a substantial portion of these workers are likely to be distributed over the surrounding area. For convenience, however, they are credited to such particular sites as 200 East, 200 West, WPPSS 1, 2, & 4, etc.

Identification of shift workers posed some reporting difficulties since some firms run four shifts while most of the others conduct their operations in three. The 100 Area was a special problem since these workers operate over a wide area. Regardless, all workers have been accounted for in this census although some of the shift counts may be approximate.

DISTRIBUTION OF WORKERS BY RADII AND COMPASS DIRECTION

Figure 2 maps the distribution of Hanford Reservation workers by work shift over intervals of one-mile radii and 16 compass directions centered at the Purex Plant. These same worker distributions are repeated in Figure 3 without the maped Reservation Area as a background. As a tabulating convenience, sector parcel counts have been rounded to units of 5 and 10, but were adjusted to the total count for the separate companies. (Because of confidentiality, worker counts for the separate companies are not being presented here.) For better readability, sector counts within the first two mile radii from the Purex Plant center are presented separately at the bottom of the figure. Table 2 presents work distribution in detail including a cumulative count of workers and percent of total as distance and direction from the Purex Plant center increases.

REFERENCE 21

Memo to file from WS Weygandt regarding Personal Communication with R. B. Hall concerning the 312 River Water Intake for 300 Area, August 13, 1987

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Battelle
Pacific Northwest Laboratories

Project Number ______________

Internal Distribution

File/LB

Date August 13, 1987

To File

From W. S. Weygandt WSW

Subject 312 Water Intake

A telephone conversation with R. B. Hall of WHC revealed that the 300 Area gets all of its water from the Columbia River through the 312 intake. The 300 Area is connected to the Richland city water supply, but this is only used during emergencies.

WSW:cs

REFERENCE 22

Letter From RD Stenner to DM Bennett Regarding Ground Water Contaminant Plumes in the 100 Area, 200 Area and 300 Area, October 14, 1987

Note: Only the attachments for the 300 Area are included here since the 100 Area and 200 Area attachments are not applicable.

Battelle
Pacific Northwest Laboratories
P.O. Box 999
Richland, Washington U.S.A. 99352
Telephone (509)
Telex 15-2874

October 14, 1987

Mr. D. M. Bennett
U.S. Environmental Protection Agency
Region X
Superfund Program
1200 6th Avenue
Seattle, WA 98101

Dear Dave:

Enclosed are the three descriptions of the 100 Area, 200 Area and 300 Area ground water contaminant plumes we discussed on the telephone yesterday. I have included some attached figures and maps to help show the independency of the detected ground water contamination in each of the three aggregate areas.

If there are any questions regarding the descriptions, please contact me at 509-375-2916.

Sincerely,

Bob

R.D. Stenner, Sr. Research Engr.
Earth and Environmental Sciences Center
GEOSCIENCES DEPARTMENT

RDS:th

300 Area Ground Water Contamination

The ground water uranium plume from the 300 Area is a discrete plume determined as the result of several years of ground water monitoring. The attached map shows the extent of the defined plume. As can be seen from the map the uranium plume is a small isolated ground water plume located at the 300 Area. Upstream samples of the surface water show that the contamination detected downstream are attributable to activity in the 300 Area. The 300 Area uranium plume enters the river between river mile 42 and river mile 43.8 as shown in the document PNL-5289 (Reference 14).

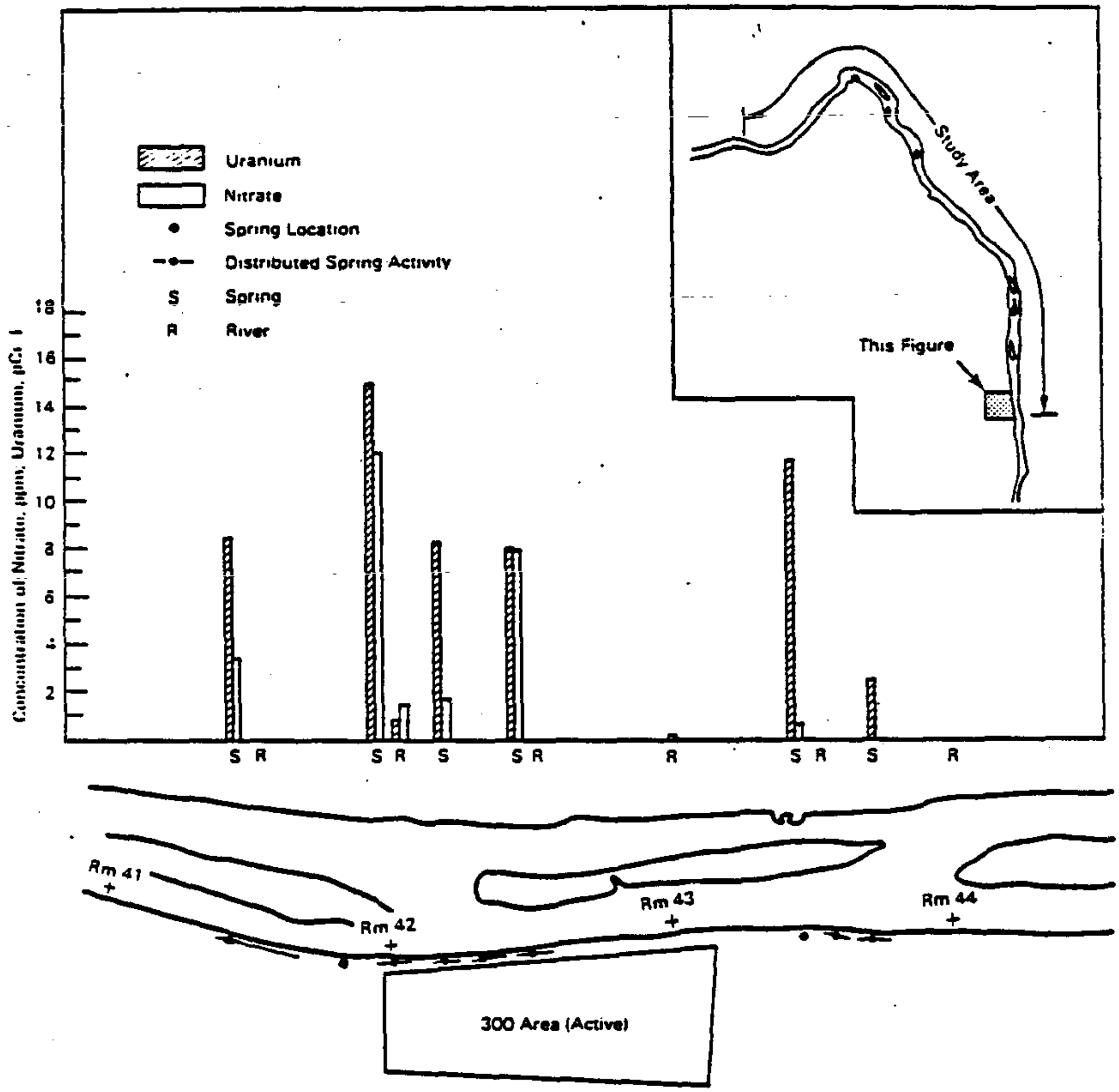
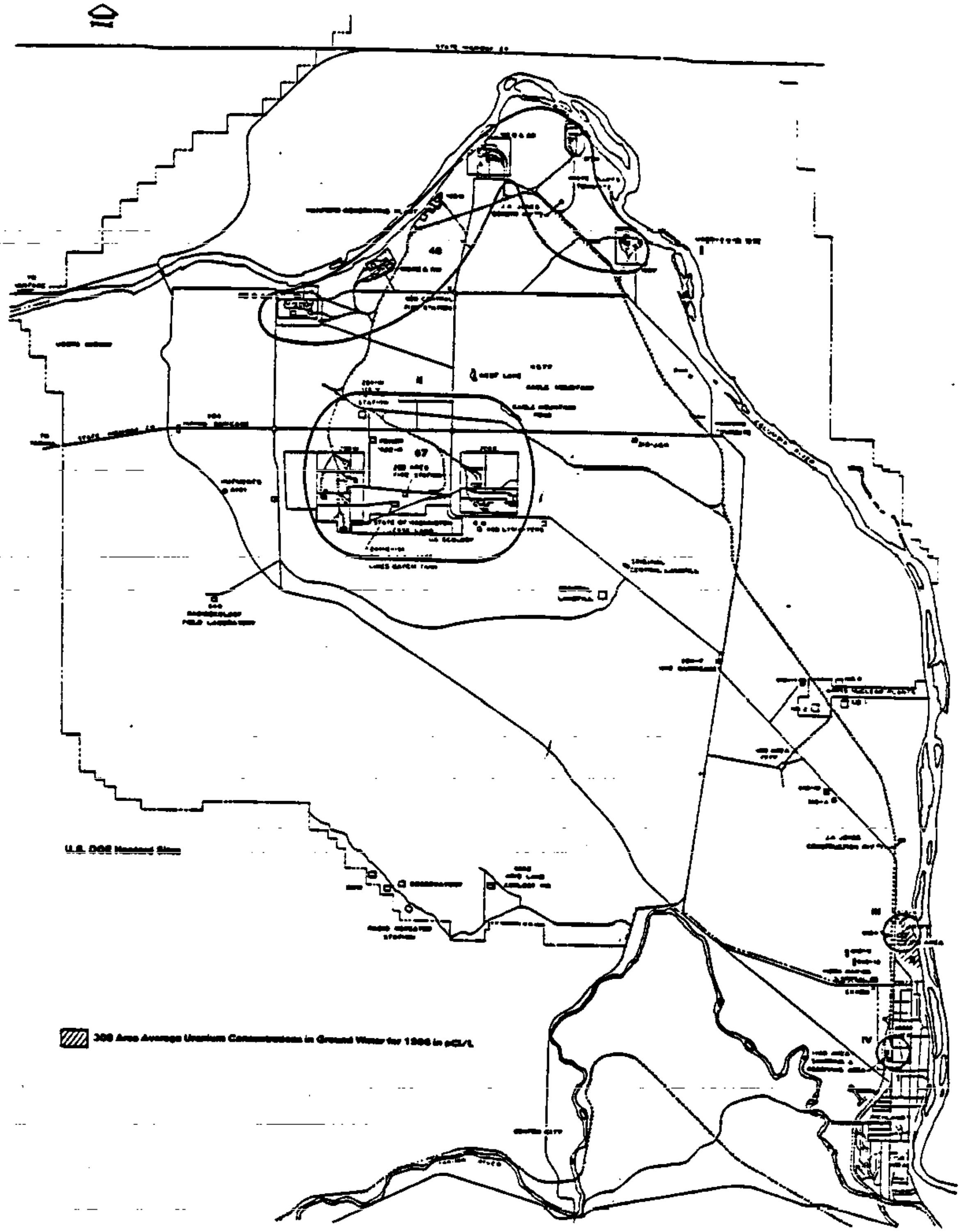


FIGURE 6. Locations and Analytical Results for Spring and River Samples - River Mile 41.5 through River Mile 44



REFERENCE 23

Memo to file regarding recreational use of the

Columbia River from DR Sherwood, August 26, 1987

Battelle
Pacific Northwest Laboratories

Project Number

Internal Distribution

KH Cramer
RD Stenner
File/LB

Date August 26, 1987

To IWSS Files

From DR Sherwood DRS

Subject Recreational Use of Hanford Reach

The Hanford Reach of the Columbia River has many recreational uses. Sportsman's access for fishing and waterfowl, big game, and upland bird hunting is provided at several locations. Access points to the Columbia River along the Hanford Reach are located at the old White Bluffs Ferry landing, the Ringold Hatchery, and Leslie Grove Park in Richland. I have fished for steelhead and salmon along the Hanford Reach since 1980.

DRS/mgs

REFERENCE 24

Letter From RD Stenner To DM Bennett Regarding Liquid Waste Sites and Burning Pits, October 26, 1987

Battelle
Pacific Northwest Laboratories
P.O. Box 999
Richland, Washington U.S.A. 99352
Telephone (509)
Telex 15-2874

October 26, 1987

D.M. Bennett
EPA/NPL Coordinator
EPA Superfund Program
U.S. Environmental Protection Agency Region X
1200 Sixth Ave.
Seattle, Washington 98101

Dear Dave:

Per your telephone request, enclosed are the statements on liquid waste sites and burning pits. It is our understanding that you will incorporate them as references in the appropriate sections of the NPL packages and provide us with a finalized copy of the packages following completion of the MITRE Corp. review.

If there are any questions regarding these statements, please don't hesitate to contact me at 509-375-2916.

Sincerely,

Bob

R.D. Stenner, Senior Research Engineer
Environmental Pathways and Assessment Section
Geosciences Department
Earth and Environmental Sciences Center

RDS:dar

ENCLOSURE

bcc: KH Cramer
MS Hanson
DA Lamar
RM Mangin - DOE/RL
TJ McLaughlin
RG Schreckhise
WB Schulze - DOE/RL
DR Sherwood

100, 200, 300 Area Statement Regarding Liquid Wastes

The general operating procedures for liquid waste sites in the 100, 200 and 300 Areas were such that the waste constituents listed for each site generally entered the process lines and were mixed with each other prior to being disposed of at the site. This process mixing of these waste constituents occurred over the period of site operation.

Burning Pit Statement

Due to the time period for which the burning pits operated, the nonhazardous combustible waste materials (i.e., paper products, cans, etc.) would have been mixed (i.e., mixed together in the garbage truck or waste container) with the hazardous waste materials (i.e., paints, solvents, etc.) prior to the waste mixture being disposed of at the site.

REFERENCE 25

<u>Waste Management Operations, Hanford Reservation</u>, ERDA-1538, December 1975

- Trilateration measurements are performed between 17 benchmarks to measure crustal motion. The initial base data were developed 3 years ago, with additional measurements at 6 months, 12 months, and 36 months from that time.

- Tiltmeters are installed at three locations on the Hanford Reservation. These pieces of equipment provide continuous geographic coverage of crustal motion. The output is telemetered to Menlo Park for interpretation.

Figure II.3-9 shows the active earthquake zones in Washington deduced from earthquake activity. East of the Cascades the trends are largely north-south, parallel to the Cascades, and divide the state into separate geographical, structural and tectonic provinces.

In eastern Washington, clearcut relationships of epicenters to specific surface faults or structures capable of faulting are not yet recognized. The suggested low rate of tectonic deformation for more than 10 million years[19] does not indicate any cause for concern. Much of the stress resulting from the continuing low rate of tectonic deformation appears to be dissipated from random epicenters along joints and bedding planes.

On the assumption that an MM-VII quake (magnitude 5.5) were to occur at the northwest end of the Rattlesnake-Wallula fault zone, ground acceleration of 13% g could be expected beneath most of the Hanford Reservation.[31] A design basis of 25% g on the Hanford Reservation thereby allows for an MM-VIII intensity quake (magnitude up to 6.8) for an earthquake epicentered at the same site. No such quake has ever been recorded in eastern Oregon or Washington.

The siting of nuclear facilities over the synclinal troughs assures the maximum distance from all hypothesized faults capable of earthquake generation. If, in addition, the Ringold Formation and Pasco Gravels are compact and undisturbed, the site is certain to pose few problems. An appreciable to high degree of conservatism appears present by acceptance of the MM-VIII quake (magnitude 6.8) and the resulting 25% g acceleration for facility design purposes.

II.3.8 Hydrology[(a)] [RP8, X.18, X.25]

II.3.8.1 Surface Water

The surface water bodies located within the boundaries of the Hanford Reservation consist of the Columbia River, various ditches and ponds in and near the 200 Areas and three ponds located in the 300 Areas (Figure II.3-10). Two ephemeral streams, Cold and Dry Creeks, appear for a short time only after heavy rainfall or snowmelt. The Yakima River borders part of the Reservation's southern boundary.

II.3.8.1.1 Columbia River

The river reach from Priest Rapids Dam (river mile 397) to the head (approximately river mile 351) of the reservoir behind McNary Dam is the last free-flowing reach of the Columbia River within the United States. The main channel is braided around the island reaches, and submerged rock ledges and gravel bars cause repeated pooling and channeling. The riverbed material is mobile, dependent on river velocities; it is typically sand, gravel, and rocks up to 8 inches in diameter. Small fractions of silts and clays are associated with the sands in areas of low velocity deposition, becoming more dominant approaching the upstream face of each river dam.[32,33,34]

The Columbia River in this reach has widely varying flow rates due to regulation by the power producing Priest Rapids Dam just upstream (Figure II.3-11). Flows during the summer, fall and winter vary from a low of 36,000 cubic feet per second (cfs) to as much as 160,000 cfs each day. The long-term annual average flow at Hanford is about 120,000 cfs,[35] but during low flow periods, daily flows average 80,000 to 90,000 cfs. The mean annual flow rate for 1972 at Hanford was 159,500 cfs. In recent years, peak flows during the spring runoff have ranged from 160,000 to 550,000 cfs; the maximum flood peak of record is 693,000 cfs in 1948.

The river width in the Hanford reach varies between 400 and 600 yards depending upon flow rate and position along the river.[36] The depth at the deepest part of the measured cross-sections varies approximately from 10 to 40 feet, with an average around 25 feet. Daily fluctuations in depth caused by Priest Rapids regulation can be as much as 10 feet above Vernita and 5 feet at Hanford. The maximum velocities measured vary from less than 3 feet per second (fps) to over 11 fps, again depending upon the river cross-section and flow rate.

(a) Appendix II.3-D provides a more detailed description of the hydrology of the Hanford Reservation. In 1973 Atlantic Richfield Hanford Company authorized an independent review, recently completed, of the hydrology program.

REFERENCE 26

Geology and Hydrology of Radioactive Solid Waste Burial Grounds at the Hanford Reservation, Washington,

USGS 1976 open file: 075-625

Dispersion brought about by such ground-water movement may account for the tritium in the ground water at the west end of Gable Butte. Although the tritium in the 200 Areas is not shown as being connected with the tritium north of Gable Butte and Gable Mountain, it is conceivable that tritium could move into this area by ground-water flow around the west end of Gable Butte northward through the gap between Gable Butte and Gable Mountain. The Columbia River water that enters the ground is unlikely to be the source of the tritium concentrations that are mapped. The river water has a tritium concentration on the order of 2 pico curies per mililiter (pCi/mℓ) (Bromson and Corley, 1972, p. 1), whereas wells 699-72-88, -72-92-0, -72-98, which define the extent of tritium contamination at the east end of Gable Butte have water with tritium concentrations of 20 to 30 pCi/mℓ (Kipp, 1973, p. 22).

Conditions at the Solid Waste Burial Grounds

The burial grounds and other solid waste storage sites can be divided into two categories: (1) those lying in the low terraces adjacent to the Columbia River mainly at the 100 Areas and the 300 Area, and (2) those lying on the high terrace south of Gable Mountain in the 200 Areas. The burial grounds in the first category are inactive except for 2 sites in the 100 F Area, one in the 100 K Area, and one in the 300 Area where mainly laboratory wastes are being buried, and the 100 N Area where fuel element spacers are stored. Most solid wastes are now being buried in the 200 Areas.

The waste material contents (including radionuclide activity) of the burial grounds are not well known for all burial grounds, because precise by well number and were available to the project. Prior to 1967, the data are recorded on laboratory analytical reports by sample batches. Most of the monitoring data collected prior to 1957 had been placed in permanent storage in a federal records repository at Seattle, Washington. None of these data in permanent storage was inspected. It proved impractical to follow the monitoring history of more than a few selected wells in detail through the period 1957 to the present because of the difficulty of extracting data for individual wells from the records.

Some general observations can be made on the utility of the monitoring data with regard to the solid waste burial grounds. The monitoring wells on the Reservation were constructed with the intention of detecting movement of radionuclides from cribs, swamps or sumps, and other liquid waste disposal facilities. However, with the exception of 9 monitoring wells (designated by the prefix S6-E4) near the 300 North Burial Ground, where a crib is also located, the placement of a monitoring well near a solid waste disposal site was only by happenstance, or the result of geographic proximity or superposition of solid and liquid waste disposal areas. Only about 5 wells (other than the S6-E4 and 200 Area wells) are situated so as to intercept contaminants leached from the solid waste burial grounds. It appears, however, that any contaminants that may have been leached from solid waste burial facilities are masked by the contaminants from liquid waste disposal.

At few wells was monitoring carried through a long period of time for more than one chemical constituent or type of radioactive determination.

The records are fragmentary apparently because multiple types of analyses were only continued long enough to trace the passage of a particular plume of contaminants that was anticipated to pass a well. The number of analyses was reduced as the level of concentration of the contaminant decreased. Tritium content, beta activity, and nitrate concentration are the most commonly analyzed characteristics or constituents. The detection limits of tritium and beta activity have varied over the years making comparisons within one record difficult. Tritium should be an indicator of liquid wastes from both reactor and fuel reprocessing plants. Beta activity may have either liquid or solid wastes as the source. Alpha activity, which is only selectively analyzed near some cribs, may be from either solid or liquid wastes. Nitrate in large concentrations is associated with liquid wastes, but is naturally present in the ground water in low concentrations. Some nitrate may also be present from agricultural fertilizers, used mainly prior to building of the Hanford Works. The spectrum of analytical data appears to be inadequate to define selectively the materials that may be leached from the burial grounds.

100 B Area

The 100 B Area, the most westerly of the reactor areas, is approximately centered on Hanford coordinates N70,000 and W80,000. It contains three burial grounds, one east of the 105-B reactor, one east of the 105-C reactor, and in the southwestern part of the area (fig. 11). The burial ground east of the 105-C reactor is considered terminated and is monumented. The other two burial grounds are unused but as of January 1973 were not officially considered terminated. The locations shown for these latter two burial grounds are approximate within an error of about 50 feet.

Surficial materials in the 100 B area are sand and coarse gravel and the burial grounds are backfilled with the same material. The two burial grounds east of the 105-B and 105-C reactors are on flat or gently sloping ground with no prominent surface drainage.

At the burial ground in the southwestern part of the area, individual burials are marked by concrete posts with brass identification plates. The general land slope is to the north. There are no prominent surface drainage features at or near the burial ground. A small area immediately north of the burial ground is 6-8 feet higher than the northern end of the burial ground. It is possible that runoff could accumulate on the surface at the north end of the burial ground and infiltrate into the ground.

Water-level data are insufficient to define the slope of the water table and the direction of ground-water movement. Although the figure 8 water-table shows no contours in this area, the approximate position of the 400-feet water contour is shown in figure 11. The regional direction of flow is generally toward the river in a northern or northwesterly direction. During times when the Columbia River is at high stage, bank storage entering the ground reverses the gradients and water flows away from the river.

The geologic units underlying the 100 B area along section F-F (fig. 12) are shown in figure 15.

The burial grounds are 50 to 70 feet above the water table, which lies within the glaciofluvial deposits as shown in figure 13. Except when the river is at high stages, it is probable that radionuclides carried downward to the water table by percolating soil water, would move to the Columbia River through the permeable glacial deposits. The Yakima Basalt lies at altitudes of about 100 to 200 feet below sea level. There is a 500- to 600-foot thickness of Ringold sediments including the lowest "blue clay" zone between the glaciofluvial deposits and the Yakima Basalt. It is unlikely that radionuclides from the 100 B Area burial grounds would enter the basalt in the immediate area before being discharged to the Columbia River.

Ground-water samples to monitor radionuclide concentrations were collected at wells 199-B-3-2 and 199-B-4-4. At well 199-B-3-2, 4 water samples collected in 1956-57 showed Beta activity on the order of 10^3 pCi/ℓ, which probably was the detection limit at that time. A later series of samples beginning in 1967 and collected at intervals varying from monthly, quarterly, to semi-annually, with an 18-month period of no record during 1967-69, showed maximum concentrations of about 5×10^3 pCi/ℓ which declined during 1969 and 1970 to about 10^{-2} pCi/ℓ. Several samples taken since 1962 contained 1 to 3 ppm nitrate. As this well is close to a crib and detention basins (107-B, 107-C), it is presumed that the radioactivity resulted from reactor cooling water building. Segment G is south of the 105-DR building. The DR Gas Loop site south of the 105-DR building is also considered as a solid-waste burial by Karagianes (1972, fig. 14).

Surface materials at all burial grounds in the 100 D area are sand and coarse gravel, containing cobbles, with a sparse vegetation of weeds. Burial ground no. 1 is marked by monuments, and surface drainage is east and northeast to a swale southeast of the 105-DR building. Burial ground no. 2 is monumented. Its surface is smooth to gently rolling and has no prominent drainage features. Water could collect in subtle depressions on the surface. In general, surface drainage from burial grounds no. 3 and 4 would be southerly to a swale southeast of 105-DR building. Within burial ground no. 3 are bladed-up mounds of soil and an apparently active trench at its east end.

The water-level data for 2 wells in the area indicate that the water table slopes northerly (fig. 16). Ground water that receives any radionuclides from the burial grounds should move to the Columbia River within a few thousand feet of the burial grounds during low and normal stages. When the 107-D and 107-DR detention basins were operated, a ground-water mound doubtless was built up to sufficient altitude to cause ground water to move easterly and southeasterly to the Columbia River at the opposite side of its bend around the reservation.

The character of the materials underlying the area along section line G-G' (fig. 15) are shown in figure 16. The bottoms of the burial grounds are about 55-65 feet above the water table. The saturated zone extends 5-15 feet above the base of the glaciofluvial deposits. Radionuclides reaching the water table from the burial grounds would move to the river mainly through the glacial deposits. The surface of the Yakima Basalt is indicated to be at an altitude of about 100 feet by Brown (1962, fig. 6). It is unlikely that radionuclides leached from the burial grounds would enter the basalt at or near the 100 D area before the ground water discharges to the Columbia River.

Wells 199-D-2-5 and -D-5-12 have been monitored for Beta activity, tritium, and nitrate in the ground water. These wells possibly intercept radioactivity moving from burial grounds nos. 1, 3, and 4. Beta activity at well 199-D-2-5 was monitored on a monthly to quarterly basis from 1967-69. A single sample taken prior to this monitoring period had a Beta activity of about 5×10^4 pCi/ℓ. This and two samples taken during March and April 1967 showed a greater level of Beta activity than the other samples, which consistently had a Beta activity of about 10^2 pCi/ℓ. At well 199-D-5-12 Beta activity was monitored from mid-1967 to present. Unfortunately, the record at this latter well does not extend back through the period when the relatively high Beta activity was obtained at well 199-D-2-5. The character of the fluctuations in Beta activity at 199-D-2-5 suggest either that a minimum of two small slugs of contaminants passed that well in a short period of time or that the samples were contaminated during collection. The Beta activity at well 199-D-5-12 has been rather uniform within the range >10^2 to 5 x 10^2 pCi/ℓ. The tritium and nitrate content of water samples from these two wells were determined for 1971 and 1972. At well 199-D-2-5 tritium rose from about 4 x 10^3 to 10^4 pCi/ℓ and nitrate rose from 2 to about 75 ppm during 1971 and 1972. At well 199-D-5-12 tritium fluctuated between 6 x 10^3 and 10^4 pCi/ℓ during 1970-1972 and nitrate rose from about 10 to about 65 ppm from 1971-1972. Both monitoring wells almost certainly are intercepting wastes moving northeastward from the 100 N area where a groundwater mound has been built up by discharged waste water. Such a direction of movement is indicated by figures 9 and 10. It appears that the contaminants reaching these wells from the 100 N Area make the record obtained from them of little value in evaluating the possibility that radionuclides may be entering the ground water from the solid waste burial ground.

100 F Area

The 100 F Area is on the eastern limb of the bend of the Columbia River at Hanford Plant coordinates N79,000 and W31,000. Terminated and monumented burial grounds nos. 1, 2, and 3 are in the southwest quarter of the area (figs. 17 and 18). Battelle Pacific Northwest Laboratories operates a burial ground for radioactive refuse from biological experiments at the south side of inactive burial ground no. 1. Battelle PNL also operates the so-called Sawdust Repository, east of the 100 F area, where litter from animal pens containing small amounts of radioactivity is buried as a land fill.

The soil material at the inactive burial grounds is sand and coarse gravel. Vegetation is sparse. The surfaces of the burial grounds are graded fairly smooth. At burial ground no. 2, the land surface is several feet above swales and linear depressions bordering it. Wind deflation appears to have removed some of the soil cover from an area on burial ground no. 2.

The water table is not clearly defined by the ground-water level information for the area but it appears to slope northeasterly toward the Columbia River. There may be a low ground-water mound built up in the vicinity of the 107 basin as a result of waste water discharge from the Battelle laboratory operation.

The water table lies within the glaciofluvial deposits, as shown in figure 19, and is within 10 feet of the land surface at the southwest part of the 100 F area. The depth to water increases northeasterly across the area, mainly because of a rise in the land surface. The water table is close to the surface in the area where burial grounds nos. 1 and 2 are located. Conceivably the water table could rise into burial ground nos. 1 and 2 as a result of a high stage of the Columbia River. Burial ground no. 3 and the Sawdust Repository are on higher ground and the depths to the water table are somewhat greater. The water table lies within the glaciofluvial deposits, through which the ground water from the vicinities of the burial grounds can move freely to the Columbia River within distances of a few thousand feet. The Yakima Basalt lies at about sea level beneath the 100 F Area, and 300 feet or more of the Ringold Formation lies between it and the glaciofluvia deposits. It is unlikely that radionuclides leached from the burial grounds would enter the basalt before reaching the river.

Monitoring records of radioactivity at wells 199-F-5-1 and 199-F-8-1 were inspected. Water sample analyses on both these wells are sparse. Thirteen samples analyzed for Beta activity from well 199-F-5-1 from 1956 to 1962 indicate that some contaminants reached this well in 1958 and persisted through 1962. Source of these radionuclides probably was the 107 detention basin or a nearby crib. Samples analyzed for Beta activity in 1967-68 were at laboratory detection levels. Tritium and nitrate analyses for 1971-72 indicate that negligible concentrations, if any, of these contaminants were in the ground water at this well. It is improbable that continued surveillance would provide any data useful in evaluating the burial grounds. The well is too far from the abandoned burial grounds and not in the path of ground water moving below the Sawdust Repository, but samples from it may show if radionuclides move away from the crib.

Well 199-F-8-1 is near burial ground no. 3 but the well appears to have been installed to monitor liquid waste discharge to a crib between it and well 199-F-8-2. Few analytical data were found for this well. Four analyses for nitrate in 1962-63 indicated that the water in the well was contaminated (11 ppm) in June 1962, but the other 3 samples contained about 1 ppm. A later series of analyses for 1971-72 showed nitrate concentrations varying between 55 and 75 ppm.

Tritium content for this same period was fairly constant at about 2 x 10^4 pCi/ℓ. Well 199-F-8-1 reflects the contaminants in a large body of polluted ground water which partly underlies the 100 F area. This body of polluted ground water is shown in figures 9 and 10. The source of the polluted water may not be the 100 F area. This water may have moved eastward from the reactor areas on the western limb of the bend on the Columbia River, or it may have moved northward between Gable Butte and Gable Mountain from the 200 Areas and then eastward. Monitoring records of nitrate north of Gable Mountain are too few to define the source of this body of water. Beta activity was not determined for the wells in the 100-F Area so it is not known if radionuclides other than tritium are associated with the high nitrate concentrations. The value of well 199-F-8-1 is suspect in monitoring radionuclide movement from the burial grounds because of the possibility that contaminants from another source have moved into this area.

100 H Area

The 100 H Area is the most northerly of the reactor areas and is well within the bend of the Columbia River. The Hanford plant coordinates N95,000 and W40,000 intersect within the area (fig. 20). Burial grounds nos. 1 and 2 are about 1,000 feet southwest and about 1,200 feet west, respectively, of the 105 reactor building. Both of these burial grounds have been terminated and are marked by monuments. They are built up a few feet above the apparently original land surface by a fill of sand and coarse gravel. Burial ground no. 1 is bounded by broad swales. Shallow closed basins have been formed in these swales by artificial fill for a road cutting across the burial ground and by fill for the railroad line to the east. Burial ground no. 2 is in a flat area which appears to have been modified from the original topography. A few small shallow depressions lie along its margins.

The geologic materials along a line J-J' across the area (fig. 21) are shown in cross section in figure 22. The slope of the water table is not defined by the limited water-level data in the area. The water table probably is at about an altitude of 375 feet and lies within the glaciofluvial deposits. A significant ground-water mound was built up by water discharged to the 107 detention basin in years prior to 1965. Only two wells (199-H-3-1 and 199-H-4-2) are presently monitored for water-level altitude. Well 199-H-4-2, the deeper of the two, is described by K. L. Kipp, Jr. (written communication, 1973) as tapping confined ground water, presumably water in the Yakima Basalt. The water-level altitude in this well appears to be significantly higher than the water table.

The depth to the water table beneath the burial grounds is about 10 to 20 feet. Under present conditions, any radionuclides reaching the water table would generally follow a direct easterly course to the Columbia River through a distance of 3,000 to 4,000 feet. At times of high river stage, however, the direction of ground-water movement may be reversed for a time.

There is a scanty radiological monitoring record available for well 199-H-3-1. However, data from this well are not significant with regard to the solid-waste burial grounds. Ground water flowing beneath the burial grounds would not reach this well as long as the former ground-water mound existed around the 107 basin. Three analyses made during 1962-63 showed tritium to be about 10^5 pCi/ℓ and nitrate to be 10 ppm which probably were caused by local waste discharges. Beta activity, based on 10 samples, during 1967-68, was 10^2 pCi/ℓ, with one sample of 3×10^3 pCi/ℓ, which probably was contaminated during collection or was poorly analyzed. Samples were again taken from the well during 1971-72 for tritium, which was about 10^4 pCi/ℓ and nitrate, which was about 8-10 ppm. It would appear from figures 11 and 12 that these recent samples contain contaminants that entered the 100 H area by moving northeastward from the 100 N area.

100 K Area

The 100 K Area is located at Hanford plant coordinates N76,000 and W69,000. Facilities within the area have been surveyed by a land grid specific to the area. Both the Hanford plant and the 100 K grids are shown in figures 23 and 24. There is one large burial ground in that area at Hanford coordinates N77,000 and W67,000. This burial ground is not in use but is considered active and is fenced.

The burial ground is on the high river terrace on which the principal facilities of the 100 K Area are located. The surface materials and backfill at the burial ground are mainly sand and coarse gravel. These materials have been graded to a fairly smooth surface, which drains northward toward a large effluent basin. There is a burning pit a short distance north of the southeast corner of the burial ground. This burning pit is 20-25 feet deep at its center.

The water table is inadequately defined by two observation wells in which water levels are monitored. With the shutdown of the 105 KE in January 1971 and 105 KW reactors in February 1970, the ground-water mound built up by discharge of waste water to the ground began to decay. An experiment during 1973 at the 100 K Area required the pumping of a large quantity of river water. If any of this water were discharged to the ground, the water table was again modified. It is possible that, at the burial ground, the water table lies at an altitude of about 390 feet, which is about 60 feet below the bottom of the burial ground. The water table is in the conglomerate zone of the Ringold beneath the southern part of the burial ground and in the glaciofluvial deposits beneath its northern part (fig. 25). Radionuclides reaching the ground water would have a direct flow path about 2,000 feet long, northerly or northwesterly to the Columbia River through the most permeable part of the Ringold Formation and the glaciofluvial deposits (figs. 25 and 26). At least a 450-foot thickness of the Ringold Formation intervenes between the water table and the Yakima Basalt. The blue clay zone in the lowermost unit of the Ringold appears to have been reached by wells 199-K-10 and 199-K-11 at about a depth of 300 feet. It is unlikely that radionuclides from the burial ground would enter the basalt before reaching the river.

Radiological monitoring of ground water was done at wells 199-K-11 and 199-K-20. Neither of these wells is placed so as to intercept radionuclides that may move from the burial ground through the ground-water body. Well 199-K-5, which is within the burial ground, was drilled for subsurface information and its casing was removed. This well was never used for monitoring. Unless this well was refilled with care to prevent circulation through it, it may be an avenue of downward movement of radionuclides from the buried wastes.

The radionuclides in the ground water at the 100 K Area apparently were from local sources such as the effluent trench near well 199-K-20. This well was sampled 13 times for Beta activity from November 1956 to October 1959 and showed a general rise to about 10^4 pCi/ℓ. Another series of Beta activity determinations for the years 1968-72 showed levels of about 10^6 pCi/ℓ which declined throughout 1970, after waste discharges ceased, to about 10^2 pCi/ℓ. Beta activity at well 199-K-11 was low, about 10^2 pCi/ℓ during the period 1967-69 but the well was not otherwise sampled for Beta activity. Tritium apparently was released to the ground locally within the 100 K Area. Tritium determinations for the two monitoring wells are few and were made mainly during 1971 and 1972. These tritium data, though inconclusive, suggest that some tritium-bearing ground water moved southward when waste water was discharged to the ground, then moved northward toward the Columbia River as normal gradients were restored. A large body of nitrate contaminated ground water is south and southeast of the 100 K Area (fig. 10) and may move northward through the area to the Columbia River. The possibility that wastes originating outside the 100 K Area may move into the area should be considered if monitoring of the burial ground is undertaken.

100 N Area

The 100 N Area is located at Hanford coordinates N85000 and W61000. Surveying within the area based on a local 100 N grid which is shown on figures 27 and 28 along with the Hanford grid. The only radioactive solid wastes stored in the 100 N Area are used fuel element spacers, which are stored in a concrete subsurface structure containing three silos northwest of the 105-reactor building. The spacers may be retrieved through hatches in the tops of the silos. There is no likelihood of radioactivity from the spacers entering the soil materials as long as the storage structure is intact.

The surficial materials in the 100 N Area are principally sand and coarse gravel of the glaciofluvial deposits. These are underlain at an indefinite depth by the middle conglomerate unit of the Ringold Formation. The upper surface of the Ringold may range from about an altitude of 350 feet near the Columbia River to about 400 feet in the eastern part of the 100 N Area (figs. 29 and 30). At well 699-86-60, where the top of the Ringold is at an altitude of about 400 feet, the top of the blue clay unit is at an altitude of about 360 feet.

A large ground-water mound has been built up to an altitude of more than 400 feet, more than 20 feet above normal river stage, where waste water is discharged to the ground in the northeastern part of the area. Ground water has moved in all directions from this mound. The eastward moving ground water probably has carried contaminants into the 100 H and 100 F Areas. Radionuclides entering the ground-water body from the spacer storage will move toward the Columbia River under the influence of the high artificial ground-water gradient from this mound. If waste-water discharge were stopped and the mound decayed completely, movement of ground water beneath the spacer storage facility would still be toward the river but at a lower velocity. However, at times of high stage of the Columbia River, there would be a movement of water eastward beneath the spacer storage facility. In fact, during high stages, water might move in the subsurface across the part of the reservation enclosed by the bend of the river and eventually enter the river (after it had returned to normal stage) in the reach that includes the 100 H and 100 F Areas.

Although several completed wells are in and near the area of waste discharge, only test boring data are available on the subsurface materials in the southern two-thirds of the 100 N Area. Samples for radiological monitoring are collected regularly at wells 199-N-3, 199-N-4, and 199-N-10 near the waste discharge. Beta activity, tritium, and nitrate concentrations are available and originate from reactor liquid wastes.

300 Area

The 300 Area is in the southeastern part of the Hanford Reservation at S 24000 and E 13000 of the Hanford plant coordinate system. Facilities in the 300 Area are referenced to the Richland coordinate system. Both systems of coordinates are shown in figures 31 and 32.

The burial grounds in or near the 300 Area are designated no. 1, 2, 3, 4, 5, 7, 8, and 300 West. Of these burial grounds, only no. 7 is still receiving solid wastes. Burial ground no. 1 is east of the 333 building at plant coordinates S 24000 and E 13400 and is marked by monuments. Part of its surface is paved with asphalt and the remainder is graded smooth. Two small steel buildings are on it.

Burial ground nos. 2 and 3 are side by side a short distance north of burial ground no. 1 and are marked by monuments. Surficial materials are sand and gravel. A few minor depressions occur in the surface. Surface drainage is to the north.

Burial ground no. 4 is north of the 300 Area and is marked by monuments. Surface materials are sand and gravel. It is in a broad shallow swale that drains eastward to the Columbia River. Fill placed in the burial ground has blocked drainage through the swale and created a surface depression centering on the burial ground. The depression may also be partly caused by compaction of buried materials. With the present condition, runoff can collect on the burial ground and seep through it. The burial ground may also be susceptible to erosion by runoff, if the fill is washed out.

Burial ground no. 5 is also located in a swale about 1,000 feet southeast of burial ground no. 4. A burning pit, the use of which was discontinued in 1973, is within the monumented confines of the burial ground. Excavation and backfilling for the burials has considerably modified the natural drainage. The swale has been blocked by fill at the downstream end of the burial ground and an excavation was made on the upstream end. As with burial ground no. 4, burial ground no. 5 may collect runoff that will infiltrate through it, and it may be eroded by surface water.

Burial ground no. 7 is northwest of the main facilities sector of the 300 Area. It is marked by steel posts and a chain. Surficial materials are sand and coarse gravel. Natural topography consists of rolling prairie with 8-10 feet of relief. Operations at the burial ground have considerably modified the surface at places. In January 1973, a trench was open in the northern part of the burial ground in which a variety of solid wastes had been placed. These wastes contained such items as stainless steel and aluminum vessels, a tank truck body, machine equipment, a wooden ladder, and various packaged wastes. Presumably these materials were only slightly contaminated by radioactivity as access to them was controlled only by radiation signs.

The 300 West burial ground is about 1000 feet southwest of burial ground no. 7 (fig. 32) and is marked by monuments. It is a small burial ground about 20 by 140 feet in dimension. The surficial materials are sand

and gravel. The topography of the burial ground and surroundings is gently rolling. The 300 West burial ground contains uranium-bearing solvent in steel drums which were buried in 1955-56.

The water table beneath the 300 Area is affected by waste water discharges to the north and south process ponds. A low ground-water mound has formed beneath the ponds (fig. 31). This mound causes ground water that normally would move beneath the burial grounds, to follow circuitous courses to the Columbia River. The water-level data on the 300 Area are insufficient to allow the flow paths from the burial grounds to be traced. If waste-water discharges were stopped, ground water should flow easterly directly to the river after the mound decayed. All of the burial grounds are close enough to the river, so that ground-water flow beneath them is reversed when the Columbia attains high stage in late spring.

The relationships of the burial grounds to the geologic materials and the water table are shown in the cross sections of figures 33 and 34.

Within the 300 Area, the water table lies at a general altitude of about 342 feet. The more easterly burial grounds are about 20 feet above the water table; the westerly burial grounds are about 40 feet above it. The water table lies in the glaciofluvial deposits, which are underlain by the middle conglomerate unit of the Ringold Formation. Hydraulic data show that the water-bearing materials in the 300 Area have a high transmissivity and the movement of water to and from the Columbia occurs at a high rate (Tillson, Brown, and Raymond, 1969). The surface of the

Yakima Basalt is at an altitude of about 200 feet. There is a saturated section of about 140 feet of Ringold Formation and glaciofluvial deposits above the basalt. The Yakima Basalt probably is involved little, if at all, in the movement to the river of wastes originating in the 300 Area.

Radiological and chemical monitoring data are available for 14 of the wells shown in figures 31 and 32. Tritium was not determined but alpha activity and Cr^{+6} and F^- concentrations, as well as beta activity and nitrate concentrations, were measured in ground-water samples.

Apparently all of the contaminants observed at these wells are locally introduced by liquid waste discharges, principally to the process ponds. The concentrations of contaminants observed at wells decrease in a general way with distance of the well from the process ponds. Radioactivity in the ground water is caused mainly by uranium (Kipp, 1973, p. 23). Beta and alpha activities generally are low. In wells near the ponds, beta activity occasionally reaches levels of 10^4 pCi/ℓ or somewhat higher, but generally is not much higher than 10^2 pCi/ℓ. Nitrate is the principal chemical contaminant having reached concentrations greater than 100 ppm in the ground water near the ponds. Nitrate determinations on wells 399-8-1, 399-8-2, and 399-8-3 indicate that wastes from the process ponds probably have moved beneath even the most distant burial grounds.

300 North Burial Ground

The 300 North burial ground is about 2-1/2 miles north-northwest of the 300 Area at Hanford plant coordinates S 6000 and E 3000 (fig. 35). Its boundaries are delineated by monuments. The burial ground is in an area of undulating topography with 10 to 20 feet of relief between swales and hillocks. There is no plant topographic map for this area. Altitudes are available for wells and the corners of the burial ground (fig. 35). The profile of the topography shown in figure 36 was based on the U.S. Geological Survey topographic map of the Richland quadrangle (contour interval, 20 feet).

Surficial materials are sand and coarse gravel. Surface drainage from this area is eastward to the Columbia. However, the burial ground has been graded with earth-moving machines, is poorly drained, and may be in a closed basin. Seven wells were drilled east and southeast of the burial ground. Five of these wells were found in 1973 to be still in existence. Apparently one of the wells was a production well which supplied water to wash out truck bodies after wastes were delivered to the burial ground. It was reported that this wash water was disposed of in a crib adjacent to the burial ground.

The ground-water level is monitored near the burial ground at well 699-S6-E4C. This record indicates the water table to be at an altitude of about 370 feet. The water table is within the permeable glaciofluvial deposits, as shown in figure 36. The water table is about 45 feet beneath the bottom of the burial ground. The Hanford water-table map (fig. 8) indicates that ground water moves easterly from the burial ground to the river. The map of tritium concentrations in ground water (fig. 9) shows that there is a preferential movement indicated by the most southerly segment of the waste plume extending from the 200 West Area. In general, the direction of ground water should roughly approximate the line of section of figure 36. The length of the flow path from the burial ground to the river is on the order of 2 miles.

Monitoring of ground water at wells 699-2-3, 699-S6-E4C, and 699-S11-E14 indicate that wastes from the 200 West Area have appeared at all three wells. At well 699-2-3 tritium reached a level of $>10^3$ pCi/ℓ in 1969, indicating that contaminants were present. Tritium increased to 2×10^4 pCi/ℓ by October 1972. Nitrate content at this well increased in 1970 to 16 ppm and has been rather erratic in concentration since, but at levels generally of 7.5 to 10 ppm. Beta measurements were discontinued at this well before the arrival of the tritium.

At well 699-S6-E4C piezometers O and P have been sampled. Piezometer O is 148 feet deep and piezometer P is 460 feet deep. The shallow ground water is not monitored at this site. Beta activity has not been determined since 1969. However, tritium and nitrate appear to have been present as contaminants in small concentrations. In the shallower piezometer, nitrate was as high as 6 ppm in 1969. Tritium has fluctuated in recent years from 5×10^2 to 10^3 pCi/ℓ. In the deeper piezometer, tritium fluctuations were similar but nitrate did not rise above a maximum of about 2 ppm.

At well 699-S11-E12 nitrate concentrations rose to 6 to 11 ppm during 1971 and 1972, which definitely indicate the arrival of wastes. Beta activity was not monitored. Tritium was reported at low levels during 1971 and 1972, except for one measurement of 7.7×10^4 pCi/ℓ, which probably resulted from a contaminated sample or a poor measurement.

300 WYE Burial Ground

The 300 WYE burial ground is about 7-1/2 miles northwest of the 300 Area and 3-1/2 miles west of the Columbia River (fig. 1). The burial ground is inactive and is marked with monuments. The WPPSS (Washington Public Power Supply System) Hanford No. 2 generating plant is under construction to the east of the burial ground.

The burial ground is on one of the lower river terraces with an altitude of 440 feet and with a topography characterized by areas of rolling prairie and intervening broad, flat meadows. There is no plant topographic map of the burial ground area. The authors have drawn contours of the area, shown in figure 37, on the basis of altitudes obtained by WPPSS in its site investigation for the Hanford No. 2 generating plant. Land surface profiles shown in figures 40 and 41 were drawn on the basis of the topography shown on the U.S. Geological Survey topographic map of the Richland quadrangle. A low medial ridge, 4-5 feet high, trends east-west through the burial ground. Drainage from the burial ground is locally north and south of this ridge and generally eastward to the Columbia River. There are some shallow depressions at the west margin of the burial ground.

Surficial materials at the burial ground are sand and gravel of the glaciofluvial deposits. These extend downward about 45 feet, as shown in figures 38 and 39, to the middle unit of the Ringold Formation. However, the base of the glaciofluvial deposits is not definitely known in this area, and it may really lie at a greater depth of about 40 feet below the bottom of the trenches at the burial ground. There are some tubular-shaped caissons that reportedly received considerable solid radioactive wastes in the burial ground, which extend to greater depths than the trenches.

Ground water moves easterly from the 300 WYE area to the Columbia River. The lobate fronts of the waste plumes from the 200 East Area, shown by tritium and nitrate concentrations of ground water (figs. 9 and 10) indicate that ground water flow is more rapid to the north and south of the 300 WYE burial ground. These differences in the rate of ground-water flow probably result from the different transmissivities of materials in the upper part of the zone of saturation from place to place on the Reservation.

No monitoring wells are near enough to the 300 WYE burial ground to have any utility in determining if contaminants from the solid wastes are reaching the water table. Wells 699-17-5 and 699-9-E2, the closest monitoring wells, are each about a mile from the burial ground. Soil borings by WPPSS, listed on figure 39, were drilled recently. WPPSS reportedly may monitor two of these borings for water levels and radioactivity but probably in connection with liquid waste discharges or for possible leaks from the Hanford No. 2 generating plant. The monitoring record for well 699-17-5 indicates that wastes from the 200 Areas recently (1972) may have reached that well. Occasional nitrate concentrations above background concentrations have been observed at that well since 1967. These may be accounted for as due to contaminated samples or poor laboratory analyses. In 1972, nitrate contents of 5.9, 11, <0.5, and 7.7 ppm were observed in the months of February, May, July, and September, respectively. Three of these determinations are indicative of contamination.

200 Areas

The 200 East and 200 West fuels separations areas are spaced about 3 miles apart in the central part of the Hanford Reservation on a high terrace with an altitude of about 700 feet. The 200 East Area is approximately centered on Hanford coordinates N 42000 and West 52000 and the 200 West Area on Hanford coordinates N 42000 and W 74000.

The solid waste burial grounds and regulated storage sites in the 200 Areas contain most of the radioactive solid wastes from the operations at Hanford. There are 27 solid waste burial sites and 9 regulated equipment storage locations (L. L. Lundgren, Atlantic-Richfield Hanford Co., written communication, January 26, 1971). Many of the burial grounds coalesce into large areas of solid waste burials. The Atlantic-Richfield Hanford Company is presently updating drawings and maps showing the various burial grounds and other solid waste storage. Most of the burial grounds are shown in figures 40 and 41. Wastes generally have been placed in trenches in the burial grounds which were backfilled with the excavated soil material. There is also contaminated or radioactive equipment in various storage facilities. The largest such facility consists of two railroad tunnels in which are stored flat cars containing large radioactive equipment items from the Purex plant (the 202-A building in figure 40). Such stored equipment is presently retrievable.

The topography of the 200 Areas is flat or gently sloping. In the 200 East Area the slope of the land and the natural drainage is northeasterly. In the 200 West Area the land slopes and natural drainage are mostly westerly and southwesterly. Both of the 200 Areas are intensively developed and drainage is now controlled along the networks of roads and railroads, the waste-water canals and ponds, and other structures. The 700-foot altitude of the 200 Areas would seem to place them well above any conceivable extreme flood levels of the Columbia River. Unruh (1970, p. 25) states, "....a coincident failure of Grand Coulee Dam and the simultaneous arrival of breech (sic) flows from upper Canadian storage projects.....would produce a flow of only 10 million cfs past Hanford. Even this flow rate would raise the surface waters to an elevation only 560 ft. above sea level...."

The surficial materials in the vicinity of the 200 Areas are mainly sand and gravel of the glaciofluvial deposits. In the 200 West Area the surficial materials are a finer grained facies of the glaciofluvial deposits and consist mainly of sand and silt. The subsurface geology of the 200 Areas has been described by Brown (1959). Figure 42 is a topographic map of the 200 Areas taken from Brown's report and shows lines of geologic cross sections that Brown prepared. Figures 43, 44, 45, 46, and 47 are copies of Brown's cross sections and show the character of the geologic materials at depth in the vicinity of the 200 Areas.

The glaciofluvial deposits are much thicker beneath the 200 East Area than they are beneath the 200 West Area. As a result of waste water discharge, the water table has risen into the glaciofluvial deposits beneath the 200 East Area. The water table has risen considerably higher beneath the 200 West Area, but it is well within the Ringold Formation. Because the glaciofluvial deposits are much more permeable than the Ringold Formation, wastes in the ground-water system move away from the 200 East Area much more rapidly than they do from the 200 West Area. The extent of waste movement and the direction of ground-water flow from the 200 Areas is indicated by the bodies of wastes originating in these areas and moving principally easterly and southeasterly as a large plume and northerly toward the Columbia River (figs. 9 and 10).

Radiologic monitoring of ground water has been intensive in the 200 Areas and immediate vicinity. However, this monitoring has been conducted to provide operating information for liquid waste discharge facilities, consisting of cribs and ponds, and to provide information on the movement of radionuclides from liquid wastes through the ground-water system. The monitoring wells are not located to detect if materials from solid wastes have entered the soil or the ground water beneath the burial grounds.

In recent years, a considerable effort was made at Hanford to develop a predictive computer model of waste transport through the soil and ground-water system. Cearlock (1971) describes the features of this computer model system. De Mier (1972) described the use of the model relative to ground-water flow and indicates that the predictive capability of the model is poor, except for the region of the tritium plume extending southeast of the 200 East Area and shown on figure 9. The modeling of waste movement through the soil at Hanford is still in the development stage. Further laboratory and theoretical studies are necessary to determine the intereactions of wastes and soil materials and to develop suitable mathematical relationships (Battelle Pacific Northwest Laboratory, 1972, p. 2).

213 Area

The 213 Area is located on the south flank of Gable Mountain at Hanford coordinates N 54000 and W 35000 (fig. 1). It includes a concrete structure containing two vaults formerly used for storing the plutonium product of the Hanford Works and two small burial pits in the yard south of the vault structure. These pits are reported to be about 4 feet deep and to be covered with rough concrete slabs about 8 feet square. They received both solid wastes such as plutonium-bearing wipe rags and wash water used for decontamination. The wash water may have contained particulate plutonium.

The yard where the pits are located has a gently sloping surface. However, runoff can reach the area from a steep slope north of the facility.

In light of the shallowness of the pits, erosion by surface water or wind may in time release the wastes. The water table is probably on the order of 150 feet or more below the land surface. It may lie either within the unconsolidated deposits or the Yakima Basalt. The concrete slab covers probably have prevented water from infiltrating the ground. The wash water presumably could have carried either dissolved or particulate plutonium into the ground beneath the pits.

Hydrologic factors related to long-term waste storage at burial grounds

The burial grounds in the 100 Areas and the 300 Area have in common the following features: (1) nearness to the Columbia River, (2) unsaturated materials above the water table are mainly coarse-grained glaciofluvial materials, (3) the uppermost part of the saturated zone is mainly in coarse-grained glaciofluvial deposits and the middle conglomerate unit of the Ringold Formation, (4) location on low river terraces that could be flooded and eroded away without the protection provided by upstream dams on the Columbia River or they could be flooded in the event of a rupture of a dam. In the light of the hydrologic setting of these burial grounds in the areas near the river, it can be concluded that they are not suitable for long-term storage of radioactive solid wastes. Radionuclides could conceivably be leached from the wastes by infiltrating water and reach the water table, from which they could reach the Columbia River within several days to several months. Despite the dry climate at Hanford, infiltration and ground-water recharge could occur in amounts of significance to radionuclide transport in the 100 Areas and 300 Area burial grounds. The precipitation is seasonally distributed with about one-half of the average annual precipitation occurring in the winter months when evapotranspiration is negligible and conditions for infiltration are most favorable. These burial grounds are underlain by very permeable deposits, and the water table is relatively close to the surface. The possibility of water infiltrating through the burial grounds and reaching the water table is enhanced if the burial grounds have surface depressions in which water can collect, as some of them do.

The 100 Areas and 300 Area burial grounds would be flooded in the event of the "probable maximum flood" predicted by the U.S. Army Corps of Engineers (1969). However, such a flood would cause much more serious results by inundating reactor and laboratory buildings. The possible flooding of these burial grounds is not as important a factor in their evaluation as is the possibility of the release of radionuclides through the soil water and ground-water systems, which could be a continuous process.

The 300 North and 300 WYE burial grounds are on relatively low river terraces but are at a considerable distance from the Columbia River. Except for their greater distance from the river, they have all the undesirable features of the 100 Areas and other 300 Area burial grounds.

The 200 Areas burial grounds are the most favorably situated for long-term storage of any of the burial grounds in the Hanford Reservation. They lie on a high terrace underlain at depth by fine-grained materials.

The depth to the water table is on the order of 200 to 300 feet. These depths would be greater if waste-water discharge to the ground were stopped and natural ground-water conditions were restored. The great depth of the water table and the fine-grained sediments at depth make it much less likely than in the 100 Areas that infiltrating water would actually reach the water table under present climatic conditions. The fine-grained geologic materials at shallow depth beneath the 200 Areas have been shown to sorb large proportions, but not all, of the radionuclides that have been discharged to the ground in liquid wastes (Brown, 1967). These liquid wastes, however, have been treated to raise their pH to alkaline, which facilitates sorption in the soil. However, in the event of water infiltrating the burial grounds, the resultant chemical character of water-waste mixtures could be expected to be closer to natural conditions. Conceivably, large concentrations of radionuclides could be built up in a particular zone of sediments below a burial ground through sorption. This tendency for radionuclides to be concentrated in particular soil layers has been observed with regard to liquid waste disposal at Hanford (Brown, 1967, 1971). Under some circumstances such a concentration of radionuclides may be particularly hazardous should the materials be breached by erosion or should the burial ground be dug up for removal of wastes. The suitability of the 200 Area burial grounds for long-term storage cannot be evaluated with the data available. The important deficits pertain to the effects of the movement of soil water, as was discussed previously in relation to sorption and infiltration, and to the transport of radionuclides by soil water.

Conclusions and Recommendations

The following actions should be undertaken to assure that the release of radionuclides from the burial grounds will not occur.

100 Areas.--Solid waste burials in the 100 Areas are poorly inventoried for the years prior to 1969. However, file data indicate that most radioactive solid wastes in the 100 Area burial grounds are irradiated reactor components, pipes, and various metal equipment items. Most of the radioactivity in these burial grounds is believed to be in these metallic wastes and is due to cobalt-60 and other activation products. It was estimated by Corbit (1969, p. 61) that the bulk of these radioactive wastes would decay to nonradioactive states by the year 2050 though a small amount would still be considered radioactive through the year 2110. Wastes of this type would release radioactivity slowly even if subjected to continuous percolation of water through them, because the metals would have to corrode in order to release any significant amounts of soluble ions of radionuclides. Because these wastes are relatively insoluble and the radiation is due to fairly short-lived radioisotopes, such wastes probably are not serious environmental hazards. However, a review should be made of the records of disposals to identify those burial grounds or the parts of burial grounds where relatively large quantities of cobalt-60 bearing metallic wastes or other very hazardous wastes are located. At a few sites, mainly older burials, containing hazardous materials, samples should be taken of the soil below the wastes and analyzed to determine if radionuclides are migrating downward to the water table. Wells also should be constructed adjacent

to selected burial sites so as to intercept water moving beneath them in the uppermost part of the saturated zone. They should be sampled regularly and the water analyzed for chemical and isotopic constituents indicative of the waste constituents in the burial grounds. If movement of radionuclides from these burial grounds is detected, a study should be made of the advisability of removing the wastes.

300 Area.--The burial grounds in the immediate vicinity of the 300 Area are reported to contain little radioactivity. None is reported to contain plutonium except burial ground no. 1. If plutonium is present there in other than trace quantities, then removal of the plutonium-bearing wastes should be considered.

300 North and 300 WYE Burial Grounds.--Both of these burial grounds contain fission products and plutonium, apparently in large quantities. Neither can be depended upon to retain these radionuclides through long periods of several hundred to several thousand years, the time required to reduce the activity to innocuous levels. It is recommended that the desirability of removing the plutonium and fission products from these burial grounds be considered.

200 Area Burial Grounds.--The numerous burial grounds in the 200 Areas contain large amounts of plutonium, fission products, and radioactivity and are great potential environmental hazards. It is also pointed out that the high-level liquid wastes stored in the 200 Areas and now being reprocessed to salt cakes, and radionuclides in the soil beneath abandoned cribs and ditches also are a great potential hazard. It is clear that presently there is no means to predict the potential

for movement of radionuclides from the solid waste burial grounds, particularly over the many thousands of years that containment of plutonium would be necessary. The waste management plan for Hanford (Karagianes, 1973, p. 119) calls for environmental studies to determine the safety of long-term storage of the residual salt-cake from high level liquid wastes. Information developed through these studies on water and radionuclide movement through the soils beneath the 200 Areas may have a direct bearing on determining the suitability of the 200 Area burial grounds for long-term storage. In fact, these environmental studies should be designed so as to also provide conclusions directly pertinent to the burial grounds.

<u>213 Area</u>.--The two small burials of plutonium-bearing waste in the 213 Area should be considered for removal as their location and the shallowness of the burials do not assure long-term containment.

<u>General</u>.--Where necessary, the surface characteristics of the burial grounds should be modified to prevent or reduce (1) erosion by local runoff or wind and (2) collection of runoff and precipitation in depressions or swales that will add to the infiltration of moisture.

<u>Temporary storage facilities for relocated solid radioactive wastes</u>.--Solid radioactive wastes containing plutonium and other fission products, removed from burial grounds, according to the recommendations of this report, must be stored so as not to cause environmental hazards. Temporary storage for these relocated wastes should be provided in either or both of the 200 Areas. These areas already contain extensive waste management

facilities, personnel security measures are stringent in both areas, and, from a hydrologic standpoint, they are least objectionable for solid radioactive waste storage of any of the facilities areas.

The relocated wastes should be placed in facilities that will prevent any possible release and transport of radionuclides and from which they can be recovèred subsequently. Ease of recovery is desirable should later studies lead to the requirement that solid wastes containing transuranium elements and fission products be removed from the 200 Areas and placed elsewhere in a permanent repository. The facilities also should be designed so that they can be stabilized with relative ease if it is later proved that the wastes may be retained with safety in the 200 Areas.

REFERENCE 27

File note from RD Stenner to file on December 2, 1987,

regarding Landfill Operations

Date: December 2, 1987

To: File

From: R. D. Stenner *RD Stenner*

Subject: Operational Assumption for Historical Solid Waste Landfills

In historically operated solid waste landfills where hazardous wastes were suspected the operation of the landfill did not involve any separation of hazardous wastes and nonhazardous wastes prior to disposal in the landfill.

Wastes in these landfills is primarily from Hanford Site maintenance/support activities which could involve hazardous materials originating from the 3000, 1100, 300, 200 or 100 Hanford operational areas.

MEMORANDUM

DATE: 12/18/87

FROM: R.D. Stenner R.D. Stenner

RE: Addendum to December 2, 1987 Letter Regarding Historic Landfill Operations

The units associated with the December 2, 1987 letter on historic landfill operation assumptions are as follows:

Horn Rapids Landfill (300 Area)
618-10 (200 Area)
618-11 (200 Area)
213-J&K (200 Area)
Central Landfill (200 Area)

Reference 28

Memo from Kathleen Galloway, MITRE, to Sandy Crystall, EPA
December 29, 1987

MITRE

Reference 29

To: Sandy Crystall,
Acting Chief for NPL Operations,
Environmental Protection Agency (EPA)

Date: 29 December 1987

From: Kathleen Galloway, Member of the Technical Staff
The MITRE Corporation

Subject: The Toxicity of Uranium and Plutonium

Copies: B. Myers, S. Parrish

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According to Sax, uranium is a highly toxic element on an acute basis as well as on a radio-toxic basis. For this reason the Agency feels it is appropriate to assign a value of 3 for the toxicity of uranium.

Sax states that the toxicity of plutonium compounds is based first upon the very high radio-toxicity of the plutonium atom. In addition, the permissible levels for plutonium are the lowest for any radioactive element. Therefore, although a method for assigning toxicity values for radio-nuclides is not established, the language in Sax would appear to justify a toxicity value of 3 for plutonium.

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